An intervention of Safety chemical program to reduce occupational exposure and improve health among BMA Vector Control Operators

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A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy Program in Public Health
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โปรแกรมความปลอดภัยสารเคมีเพื่อลดการสัมผัสด้านอาชีวอนามัยและการปรับปรุงสุขภาพในกลุ่มพนักงานควบคุมสัตว์และแมลงนำโรคของกรุงเทพมหานคร

นายไพฑูรย์ งามมุข

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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Field of Study	Public Health
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ไพฑูรย์ งามมุข : โปรแกรมความปลอดภัยสารเคมีเพื่อลดการสัมผัสด้านอาชีวอนามัยและการปรับปรุงสุขภาพในกลุ่
พนักงานควบคุมสัตว์และแมลงนำโรคของกรุงเทพมหานคร (An intervention of Safety chemical program to redu
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โรเบิร์ท เอส. แชบเม็น, 174 หน้า.

วัตถุประสงค์: 1) เพื่อประเมินระดับการสัมผัสสารเคมี และศึกษาความสัมพันธ์ระหว่างการสัมผัสสารเคมีและสถาน
ทางสุขภาพจากการฉีดพ่นสารเคมี 2) เพื่อประเมินประสิทธิผลของโปรแกรม ความปลอดภัยสารเคมีเพื่อลดการสัมผัสด้านอาชีวอน
มัยและปรับปรุงสุขภาพ พฤติกรรมความปลอดภัยสารเคมี และสมรรถภาพปอดของพนักงานควบคุมสัตว์และแมลงนำโรคกรุงเท
มหานค

รูปแบบและวิธีการศึกษา: เป็นการศึกษาแบบกึ่งทดลองซึ่งดำเนินการในผู้ร่วมศึกษาซึ่งเป็นพนักงานควบคุมสัตว์แล
แมลงนำโรคกรุงเทพมหานคร จำนวน 96 คน ในพื้นที่ 6 กลุ่มเขตของกรุงเทพมหานคร ผู้ร่วมศึกษาแบ่งเป็น 2 กลุ่ม กลุ่มทดลองแล
กลุ่มควบคุม กลุ่มทดลองจะได้รับโปรแกรมความปลอดภัยสารเคมี ซึ่งกลุ่มควบคุมไม่ได้รับ การเก็บข้อมูลทั่วไป พฤติกรรมส่ว
บุคคล สภาพแวดล้อมการทำงาน และอาการจากการสัมผัสสารเคมีของผู้ร่วมศึกษาใช้การสัมภาษณ์โดยใช้แบบสอบสอบถามที่ไ
ทดสอบความเที่ยงและความแม่นยำแล้ว ดำเนินการเก็บตัวอย่างอากาศแบบติดตัวพนักงานเพื่อประเมินการสัมผัสสารของสาร ไซเปอ
เมทริน เบนซีนและไซลีนขณะปฏิบัติงานฉีดพ่นสารเคมี และตรวจวิเคราะห์ทางห้องปฏิบัติการด้วยวิธีของ NIOSH และเก็บตัวอย่
ปัสสาวะหลังจากการฉีดพ่นสสารเคมีเพื่อประเมินการสัมผัสทางชีวภาพ การวิเคราะห์ผลการศึกษาใช้สถิติเชิงพรรณาอธิบายลักษณ
ของผู้ร่วมศึกษา ใช้ multiple logistic regression เพื่อทดสอบความสัมพันธ์ การวิเคราะห์ประสิทธิผลของโปรแกรมภาพรวมใ
repeated-measure analysis of variance (ANOVA) สำหรับการวิเคราะห์ผลโปรแกรมของความแตกต่างแต่ละช่วงเวลาของกลุ่
ทดลองและกลุ่มควบคุม สำหรับตัวแปรเชิงปริมาณใช้วิธี linear mixed model และสำหรับตัวแปรเชิงคุณภาพใช้ generali
estimating equations (GEE)

ผลการศึกษา ผู้ร่วมศึกษาทั้งสองกลุ่มมีช่วงอายุที่ใกล้เคียงกัน 41.76±10.21 ปี พบว่าระดับการสัมผัสของสารเบนซี
0.120±0.86 mg/m^3 or 0.37±0.26 ppm เกินค่ามาตฐานของสถานบันอาชีวอนามัย ความปลอดภัยและสุขภาพสหรัฐอเมริกากำหน
(NIOSH REL Ca TWA 0.1 ppm) และพบว่า อาการระคายเคืองที่หน้า ตามัว เมื่อยล้า คลื่นไส้ มีความสัมพันธ์กับระดับการสัมผั
สารเคมี ระดับการสัมผัสทางชีวภาพ การไม่สวมอุปกรณ์ความปลอดภัยเป็นประจำ โดยเฉพาะอย่างยิ่งการฉีดพ่นสารเคมีบริเวณพื้น
ปิด อย่างมีนัยสำคัญทางสถิติ (OR 1.46, CI 0.52-4.67, p<0.05) และการไม่สวมอุปกรณ์ความปลอดภัย จะเพิ่มความเสี่ยงทางสุขภา
(OR 6.08, CI 1.61 22.9, p<0.05) ประสิทธิผลในภาพรวม และแต่ละช่วงเวลา ภายหลังดำเนินการโปรแกรมความปลอดภัยสารเคมีโ
การติดตามวัดผลทั้งสองระยะ พบว่า สามารถลดระดับการสัมผัสทางชีวภาพในปัสสาวะของสาร 3-phenoxybenzoic acid (3-PBA
trans, trans-muconic acid (tt-MA) and o-cresol เพิ่มคะแนนพฤติกรรมความปลอดภัย และลดอาการจากสัมผัสสารเคมี โดยเฉพา
อย่างยิ่ง อาการระคายเคืองที่ใบหน้า ตา ตามัว และการระคายเคืองที่ผิวหนังอย่างมีนัยสำคัญทางสถิติ อย่างไรก็ตามโปรแกรมควา
ปลอดภัยสารเคมีไม่สามารถเพิ่มสมรรถภาพปอดในกลุ่มพนักงานได้

สรุปและอภิปรายผล โปรแกรมความปลอดภัยสารเคมีเป็นสิ่งสำคัญที่ควรดำเนินการส่งเสริมปรับปรุงด้านอาชีวอนาม
ให้กับพนักงานควบคุมสัตว์และแมลงนำโรค ซึ่งสามารถลดระดับการสัมผัสสารเคมี ลดผลกระทบต่อสุขภาพอาการจากการสัมผั
สารเคมี และปรับปรุงพฤติกรรมความปลอดภัยสารเคมีได้ ข้อเสนอแนะในการศึกษาครั้งต่อไป ควรศึกษาประสิทธิผลของโปรแกร
ความปลอดภัยสารเคมีในกลุ่มพนักงานฉีดพ่นสารเคมีควบคุมและป้องกันสัตว์และแมลงนำโรค โดยมีระยะเวลาการศึกษาแล
ติดตามผลที่นานขึ้น

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต .....

ปีการศึกษา 2559 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

5579157953 : MAJOR PUBLIC HEALTH

KEYWORDS: OCCUPATIONAL CHEMICAL EXPOSURE; ACUTE HEALTH SYMPTOMS; VECTOR CONTRO OPERATORS

PAITOON NGAMMUK: An intervention of Safety chemical program to reduce occupational exposure and impro health among BMA Vector Control Operators. ADVISOR: DR. ROBERT S. CHAPMAN, M.D., 174 pp.

Objective: 1) To assess the current occupational chemicals exposure and the relationship of the between worke health condition and their exposure from spraying chemicals among Vector Control Operators (VCOs) in Bangkok, Thailand: 2) determine the effectiveness of a chemical safety intervention program designed to increase chemical behavior safety score, redu occupational chemical exposure, health symptoms prevalence, and spirometric lung function impairment.

Methods: A quasi-experimental study was conducted in six Bangkok areas among 96 male operators with two follo ups time by measured every six months. The operators were divided into two groups: the intervention group received interventio and the control did not. General information of participants including personal behavior, environmental working condition ar health symptoms were collected through face to face by using valid questionnaires. Exposure to cypermethrin, benzene and toluer were collected by using personal solid sorbent sampling during the time of chemical spraying by NIOSH method. Urine sampl were collected to evaluate biological exposure as pollutant metabolite levels. The data were analyzed by using descriptive statisti and multiple logistic regressions for test association. Overall intervention effects were assessed by repeated-measure analysis variance (ANOVA). Linear mixed models (continuous outcomes), and generalized linear models with generalized estimatir equations (GEE) (dichotomous outcomes) were used to measure and assess intervention effects at specific follow-up times (follo up 1 and follow-up 2).

Results: Average participant age was 41.76±10.21 years (mean ± SD). The exposure level of benzene was 0.120±0.8 mg/m^3 or 0.37±0.26 ppm, a figure greater than National Institute for Occupational Safety and Health (NIOSH) recommendatio (NIOSH REL) Ca TWA 0.1 ppm. The results demonstrated that facial irritation, blurred vision, fatigue, and nausea were significant associated with airborne, biomarkers. Irregular use of personal protective equipment (PPE), especially when spraying indoors (O 1.46, CI 0.52-4.67, p<0.05), and poor use of PPE among operators may increase health risks (OR 6.08, CI 1.61 22.9, p<0.05). At t baseline measure, both groups had similar sociodemographic characteristics, personal habits, and environmental workin conditions. After the intervention program, the intervention group had effectively reduced difference means occupational exposu for 3-phenoxybenzoic acid (3-PBA), trans, trans-muconic acid (tt-MA) and o-cresol. For effectiveness of intervention to redu symptoms prevalence and chemical safety score, there were also high statistically significant differences between the groups follow-ups 1 and 2, particularly had reduced eye and facial symptoms (facial burning, paresthesia, blurred vision), skin sympton (rash/itchy skin) at during working and after working. However, this intervention was not associated with a beneficial effect on lur function.

Conclusion: The findings suggest that the introduction and implementation of chemical safety programs could redu biological exposure, symptoms prevalence and improve chemical safety behavior among VCOs that lead to prevent heal symptoms due to chemical exposure. Further research is required to explain the findings regarding lung function.

Field of Study: Public Health
Academic Year: 2016

Student's Signature .....
Advisor's Signature .....

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CONTENTS

Page

Page

Page

LISTS OF TABLES

LIST OF FIGURE

CHAPTER I

INTRODUCTION

This chapter introduces the issue of vector control operators exposure to chemical in Thailand and other countries. This text outlines the objectives, research questions, conceptual framework, operational terms, and expected outcome of this study.

1.1 Background & Rationale

Vector-borne diseases are a significant health concern for human populations in many countries The World Health Organization (WHO)(Organization, 2004) has estimated around 17% of the global burden of infection disease are due to vector-borne diseases. While vector control operators(VCOs) play an important role in managing vector-borne disease programs, they are at-risk for occupational diseases caused by pesticide and chemical exposure.

Cypermethrin is a synthetic pyrethroid insecticide. It was first synthesized in 1974 (WHO, 1989) and has been widely used in agriculture, textile, industrial, and public health industries. Particularly in public health sector, this insecticide has been widely used to control mosquitoes in residential environments. Pyrethriods are divided in two types: type 1 works by poisoning via inactivation of sodium channels in the peripheral and central nervous systems (CNSs) to induce repetitive firing of action potentials, while type 2 works by holding the sodium channels open so that the membrane becomes depolarized to a point where generation of action

potentials is no longer be possible. The United States Environment Protection Agency (U.S. EPA) originally classified cypermethrin as a possible (group C) human carcinogen due to limited evidence that it causes cancer in animals (EPA). 1989) ; (Cantalamessa, 1993). USEPA later re-evaluated cypermethrin and classified it as having, "Suggestive evidence of carcinogenicity but not sufficient to assess human carcinogenic potential".(United States Environmental Protection Agency.(US EPA), 2004) Scientific evidence reports that pyrethroids exposure, including exposure to cypermethrin, can cause reduction in semen quality and increased sperm DNA damage in humans(Meeker, 2008). Upon exposure, cypermethrin enters the body primarily by inhalation and ingestion of particulate matter and spray mist, though there may also be some absorption through the skin. Humans excrete cypermethrin rapidly however, ridding themselves of around 49% to 78% within 24 hours after exposure(Organization(WHO), 1997). Cypermethrin is rapidly detoxified in the blood and liver to an inactive component, so the acute toxicity to human is thought to be limited.(Ray, 2000) Several research articles based on occupational studies have shown that acute exposure may result in dizziness, nausea, loss of appetite, and fatigue.(Singleton et al., 2014) After direct exposure at a high dose concentration, symptoms may include are paresthesia of eyes, face, and breasts, asthmatic breathing, palpitations, headache, anxiety, hyperactivity, tremors, involuntary movement, chronic seizures and confusion. After ingestion or inhalation, exposure is shown to cause an itching and burning sensation(Safety, 1989c).

The most common method of adult mosquito control is spraying by a thermal fog machine. The process requires a very small amount of the pesticide, in a range 1-50 um, to be mixed with fuel oil (diesel fuel) using thermal energy in combustion chamber. This mixture is then sprayed into the air as a fine, visible fog cloud which floats on air currents and kills mosquitoes with which it comes into contact. Previous studies show no evidence of quantitative human exposure following spraying for West Nile Virus(WNV), as there was no increase in urine concentration of the metabolite

permethrin or d-phenothrin after spraying when compared with baseline. This indicates a low environmental stability and poor skin absorption, though human exposures occur commonly((CDHS), 2005a).

While cypermethrin appears to be relatively safe, diesel fuel, a carrier for thermal fogging agents, creates a thick smoke and has a strong smell, which may lead a community to reject use(Organization(WHO), 2009). Diesel fuel is a complex hydrocarbon, containing polyaromatic hydrocarbons such as benzenes. The International Agency for Research on Cancer (IARC) has classified diesel exhaust as carcinogenic (Group 1) to humans(Cancer(IARC), 2012). Petroleum distillate may "produce eye, skin, and respiratory irritation, and symptoms of CNS depression, such as headache, dizziness, nausea, and vomiting"((CDHS), 2005a)

In 2013, a pilot study of an Occupational Health and Safety Program in 109 vector control operators was conducted by Environmental Sanitation Section, Health Department, BMA. The results showed that 30.2% of participants had training on the usage of proper personal protective equipment (PPE), 18.3% were read the pesticide labels to get health hazard information, and 69% of spray-operators never drank, ate, or smoked while spraying. Operators reported symptoms of dizziness (25.8%), nausea (12.9%), fatigue (34.4%), headache (33.6%), and difficult breathing (34.4%). In addition, 54 volunteer mosquito control sprayers of the Royal Thai Army developed health symptoms after exposure to pesticides including upper respiratory issues (75%), dizziness and nausea (59%), headache (37.5), shortness of breath (18.8%), chest tightness (12.5%), and hand and face numbness (3.1%)(Kongtip, 2013). These results conform to several previous studies. In a cross-sectional study of 1,102 farmers in Australia, up to 40% of farmers did not use PPE routinely when handling pesticides(MacFarlane, Carey, Keegel, El-Zaemay, & Fritschi). Vector control operators often use improper PPE (Karunamoorthi, 2012). Mosquito control sprayers should use protective clothing made of plastic, nylon, or polyester to protect skin from pesticide contact(Kongtip, 2013).

Pesticide safety training programs on use of PPE and safe pesticide handling are important and essential interventions for reducing the health hazards of pesticide exposure in occupational settings. These programs could be used effectively to control respiratory disease(Ye, 2003). Participants who reported wearing gloves saw a reduction in the harmful effects of pesticides, and those who received pesticide safety training had a higher use PPE, like gloves (Levesque, 2012). (Perry & Layde, 2003) found pesticide safety training which involves education on perceived risks, knowledge of risks, understanding of susceptibility of exposure, self-efficacy, and skills training can increase the use of PPE among pesticide applicators and farmers.

Previous studies show the intervention program has been used successfully in other areas of health concern, indicating it will fit well into a pesticide PPE program. However, few studies were found that used the health belief model in workplace or occupational health interventions(Janz, 2002) . Few studies on chemical exposure (BTEX) among vector control operators, especially biological exposure index, were also discovered. This study will propose an integration of intervention program with chemical hazard education to train vector control operators. The information gained from this study will be useful to public health technical staff for establishing pesticide safety training programs to reduce or prevent chemical exposure in vector control operators.

1.2 Research question

1.2.1 What is the effectiveness of safety chemical program to reduce the operators' spraying-related chemical exposure, health symptom, lung function impairment and to improve safety behavior of pesticide use among Bangkok vector control operators?

1.2.2 What is the current exposure to diesel exhaust and cypermethrin, as measured by daily duration of spraying?

1.2.3 What is the current relationship (before intervention) of the operators' health situation with their occupational chemical exposure from spraying?

1.3 Research objectives

1.3.1 General objectives

To determine the effectiveness of safety chemical program to increase safety behavior score, to reduce occupational exposure and improve health among vector control operators in Bangkok, Thailand

1.3.2 Specific objectives

1.2.2.1 To access a situation of cypermethrin, benzene and toluene exposure among vector control operators in Bangkok.

1.2.2.2 To investigate occupational risk factors associate with health workers symptom.

1.2.2.3 To determine the effectiveness of safety chemical program using the integrate health belief model among vector control operators in Bangkok, Thailand by:

- Compare biological exposure index (BEI) of cypermethrin, benzene and toluene concentration before and after intervention program among intervention and control group.
- Compare health prevalence symptoms before and after intervention program among intervention and control group.
- Compare pulmonary function test (FVC, FEV_1, FVC/FEV_1, MMEF, FET and PEF before and after intervention program among intervention and control group
- Compare safety behavior score of pesticide use before and after intervention program among intervention and control group

1.4 Research hypotheses

1.4.1 There is association between occupational risk factors and health symptoms operators

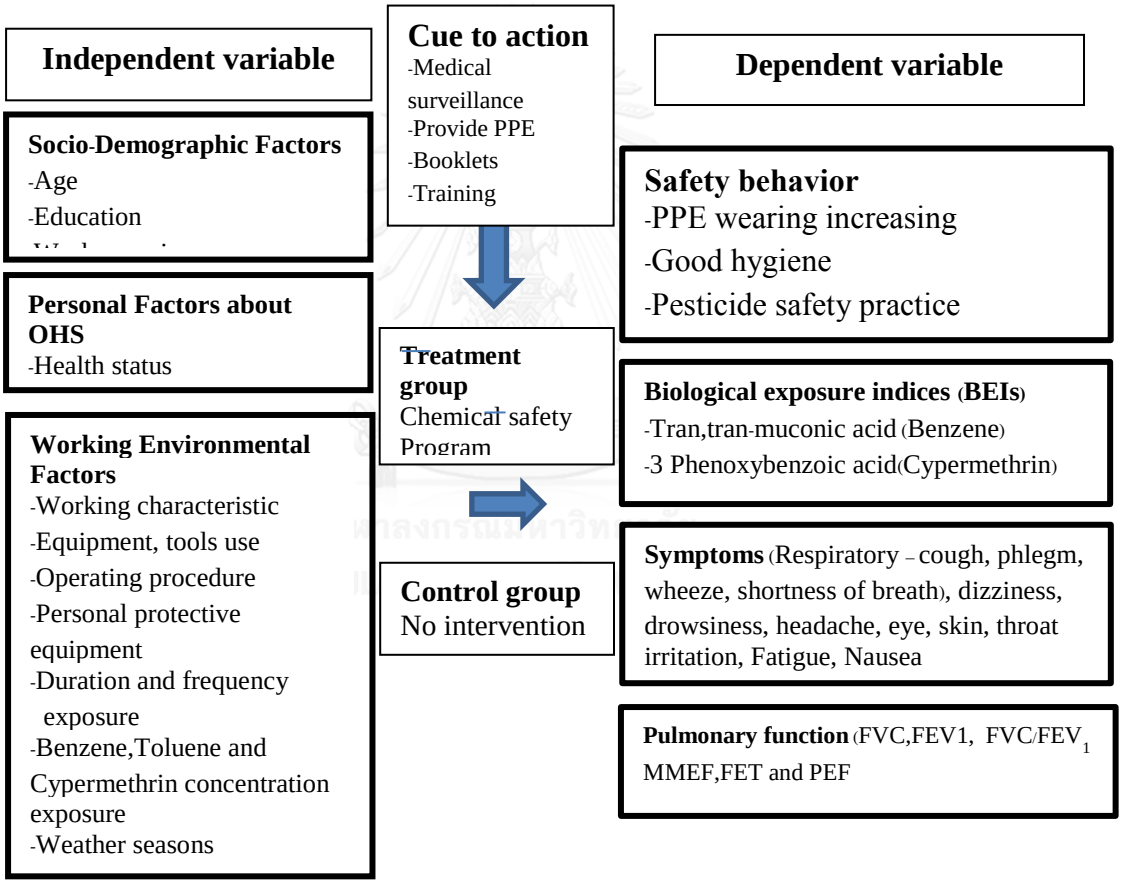
1.4.2 There is difference of cypermethrin, benzene and toluene exposure of vector control operators between intervention and control group.

1.4.3 There is difference of health symptoms of vector control operators between intervention and control group.

1.4.4 There is difference of pulmonary function of vector control operators between intervention and control group.

1.4.5 There is difference of safety behavior of vector control operators between intervention and control group.

1.5 Conceptual framework



1.6 Operational definitions

1.6.1 Occupational exposure is referred to pesticide (Cypermethrin) and diesel (Benzene) exposure while the vector control operators (VCO) are spraying pesticide to kill adult mosquito.

1.6.2 Improve health is referred to improve health symptom and lung function impairment which relate spraying occupational exposure.

1.6.3 Vector control operators(VCO) is defined person who employees of Bangkok Metropolitan Administration(BMA) which work carry out mosquito control. Pesticide in this study mean liquid of cypermethrin formulation is mixing with diesel fuel in formulation ratio 1: 50

1.6.4 Thermal fog machine spraying refers to spraying with machine to generate a fog droplet 5-50 microns in diameter to kill adult mosquito.

1.6.5 Exposure, occupational and environmental exposure is defined as the process of contact at a boundary between human and the environment with a contaminant of specific concentration for the interval time

1.6.6 Exposure pathways is referred to as the process which a pollutants exists from the source of chemical or agent to human bodies exposure

1.6.7 Exposure route is referred to as the way of harmful environmental condition factors such as chemical, biological, physical agent enters to human bodies.

1.6.8 Dose is referred as "the amount of a pollutant that may enter the body is usually only part of the exposure and is referred to as the dose". Dose can divided three term are absorbed dose(internal dose),target organ dose and biological effect dose

- *Absorbed dose*(internal dose) is referred as "the amount of an agent that can passes into a tissue or organ over the time"
- *Target organ dose* is referred as " the integrated concentration of the agent in the target organ, that is the organ where the particular agent may cause an adverse health effect"
- *Biological effect dose* is referred as "the intergraded quantity after subtraction of non-contributing fraction of dose or biotransformed proportion of substance that may cause an adverse health effect"

1.7 Benefit and outcome of this study

1. Results of this study will be known health hazard and proper measures to reduction chemical exposure in vector control operators.
2. Health department of Bangkok Metropolitan Administration will be receiving knowledge body to improving working condition and setting occupational health and safety policy and guideline for prevent and control occupational health disease of vector control operators.
3. Results of this project, we are expected to benefit Health Department, BMA seeking more effective procedure to improve occupational health and safety management in other operators who expose similar chemical exposure.

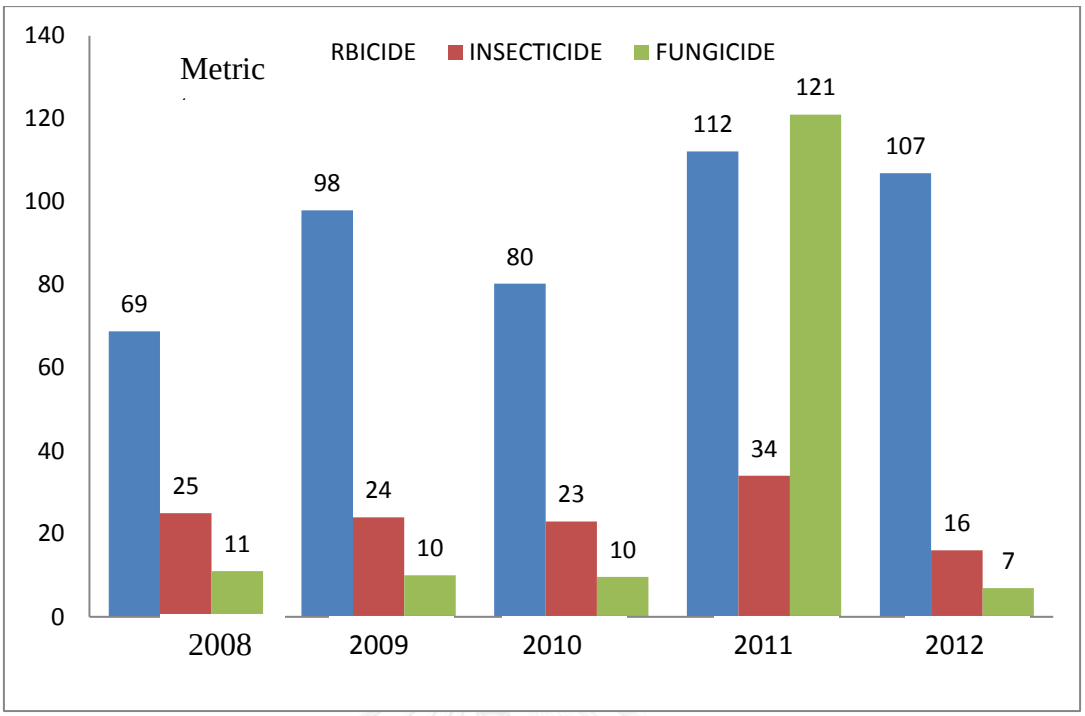
CHAPTER II

LETERATURE REVIEW

2.1 Chemical occupational exposure in spraying vector control operators problem

Pesticide is widely used for chemical control method in agriculture and vectors-born disease such as malaria, dengue, hemorrhagic fever(Jeyaratnam, 1990). Nation and (FAO) (1989) defines a pesticides as " any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or disease, unwanted species of plant or animal causing harm during or otherwise interfering with products or animal feed stuff or which may be administered to animals for the controls for insects, arachnids for other pest in or on their bodies" (p23). WHO state that "vector-born disease is among the causes of illness and death in the South-East Asia Region., the WHO survey report of global insecticide uses for vector-born disease control showed more than 3200 metric tons of DDT (80% of global used pesticides), 225 metric tons of active intergradient of organophosphates and 30 metric tons active intergradient of pyrethroid have been used for vector-born disease control in the South-East Asia counties 2006-2007(WHO,2009)

Almost all of pesticides use in Thailand were imported. In 2012, the Office of Agriculture Economics, Department of Agriculture, Thailand reported that the quantity of importing pesticides between 2008 to 2012 were around 1328 metric tons(Office of Agriculture Economics, 2014). Over this period, the three most frequently used pesticides in Thailand were insecticides, herbicides and fungicides respectively which have increased rapidly over the past five years present in Figure 2.1

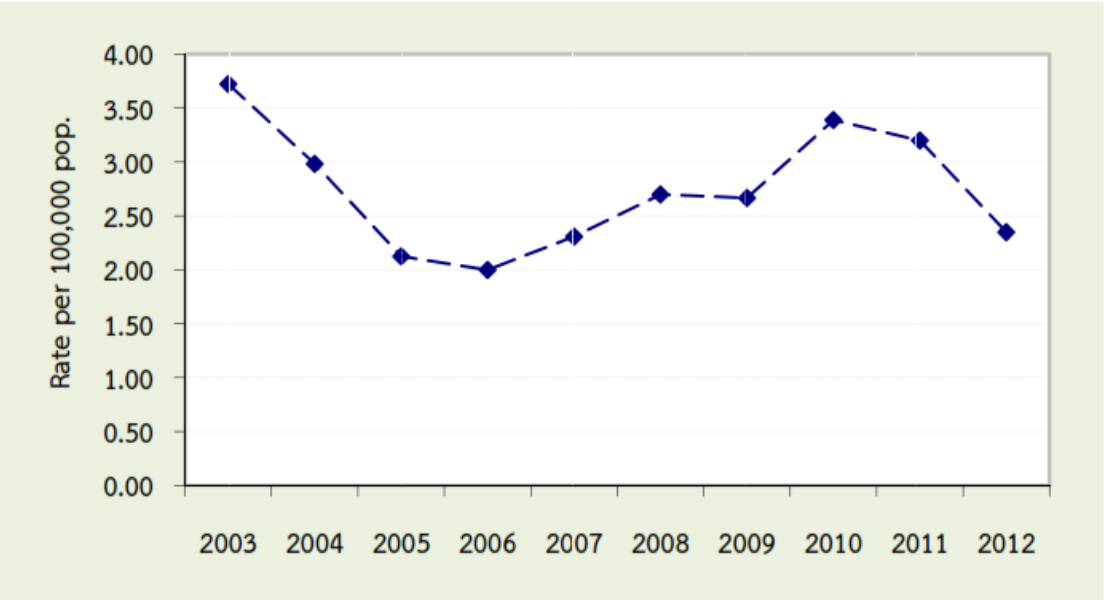


Source The statistic of pesticide imports to Thailand 2008-2012(OAE ,2012)

Figure 2. 1 The quantity of pesticide imports to Thailand between 2008-2012

In developing counties, pesticide poisoning is a serious public health problem (Xue,1987; Jeyaratnm,1990) and lead to more deaths than infectious diseases. WHO estimated around 20,000 workers in developing counties die from pesticides exposure every year (Pimental, 1992);(Kishi, 1995). One of the main problem of pesticides poisoning of workers is Acute Pesticides Poisoning (APP), WHO estimated of occupational APP in Central America (Belize, Costa Rica, ElSavador, Guatemala, Honduras, Nicaragua and Panama) , 180 cases per 100,000 population in Sri Lanka (Eddleston et al ., 2006) and about 20 cases per 100,000 population(WHO,2002),about 17. 8 cases per 100,000 population in Thailand respectively (Thai Food and Drug Administration. , 2003).

Furthermore, pesticide poisoning among farmer and occupational workers is very important public health problem(M. e. al, 2006). In United states, Calvert and coworkers have reported 18 cases related with occupational pesticides exposure, there were more than 100,000 workers which related pesticides exposure illness.(Calvert, 2004). In Thailand, Bureau of Epidemiology, Department of Disease control, Ministry of Public Health has reported the situation and health effects related pesticides exposure between 2003 to 2012, The Figure 2 showed the total number of patients around 17,340 case, the average patients per year were 1,734 cases and the morbidity rate 2.35 cases per 100,000 population which trend have slightly decrease over the past decade(Department of Disease control, 2013).



Source: Department of Disease control, Ministry of Public Health (2013)

Figure 2.2 Prevalence rate of pesticides exposure between 2003 to 2012

2.2 Diesel fuel hazard

Chemical control is essential method to reduce populations of vector born species (Matthews, 2011). The most common method for adult mosquito control is used thermal fog spraying, this process generates very small of pesticide which mix with fuel oil (diesel fuel). Then spray pesticide into the air as a fine mist of droplets which float on the air currents and kill mosquitoes that come into contact with them. Diesel fuel has been use as a carrier for thermal fogging agent, but it creates thick smoke, has strong smell, which may lead to community to reject it use. (WHO,2009)

Diesel fuel is a complex mixture of hydrocarbon which the components distill from petroleum crude oil process (ATSDR, 1995). U.S. Department of Health and Human Services reported that the component of diesel fuel contains several health hazard or toxic substance such as benzene, toluene, ethylbenzene, and xylenes (known as "BTEX" compounds (ATSDR, 2010). Many research institute have determined that benzene is a human carcinogen (The Department of Health and Human Services,2010; (ATSDR,2010)). Diesel vapors and also gasoline vapor exposure that can lead to irritate eyes, nose, throat and lungs. Over short-term exposure can lead to dizziness, loss of coordination, headaches, nausea, asphyxiation and lung damage (Lagorio S, 2009)& (Peters S, 2013). Moreover, excessive skin exposure of diesel fuel can cause irritate the skin and can lead to redness, pain and chemical burn blisters.

Many researchers study BTEX occupational exposure. Rezazadeh and coworker conducted occupational exposure of petroleum depot workers to BTEX compounds, the results found that the gasoline loading operators were exposed to relatively high level of benzene 0.16 to 1.63 ppm (RezazadehAzari, 2012). In gasoline station, workers who exposure BTEX compounds would increase the risk of cancer (Tunsaringkarn, 2012). Worker who exposed pyrethroid pesticides with petroleum oil, the results showed OR = 1.26, 95% CI: 1.09–1.47 can lead to respiratory symptoms and associated with wheezing (Hoppin, 2006). Another study,102 pesticide sprayers and 69

non-sprayers in state farms of Ethiopia were tested lung function, results showed that pesticide sprayers had significantly reduced FEV_1 and FVC when compared to controls group(Mekonnen Y., 2006).

2.3 Occupational exposure assessment

Exposure, occupational and environmental exposure is defined as "the process of contact at a boundary between human and the environment with a contaminant of specific concentration for the interval time and a substance which human can get into the bodies by one or more of four routes: by inhalation, skin contact, ingestion, or by injection. Exposure is focusing on "pollutant of interest to the individual, and to the time and duration of exposure"(PJ, 1990).

Exposure assessment is the science to describe the characterizing of the pathways, to describe the nature , size, concentration of pollution substance related to magnitude and time duration of exposure to determine the degree of contact of person and estimate the quantity or magnitude exposure dose.(L. e. al, 2005)

Exposures to pollution substance or toxic environmental contaminants are very important for public health problem; there are significant risk factors in occupational health and disease. Johnson described relationship between source concentration, exposure, dose and risk factors lead to disease and suggested environmental and public health staff for should have knowledge of the source of the exposure, transport pathways, the exposed population, exposure levels, and routes of the exposure as contaminants enter to the body for clearly picture of risk factors and disease(Johnson, 1992).

Exposures can measure as quantified concentration of pollutant or agent in a source (air, water, soil, food) with human contact over time (duration) of contact.

National Research Council calculated the intensity of exposure with depend on exposure concentration as a function of time and duration of exposure(NRC,1991)

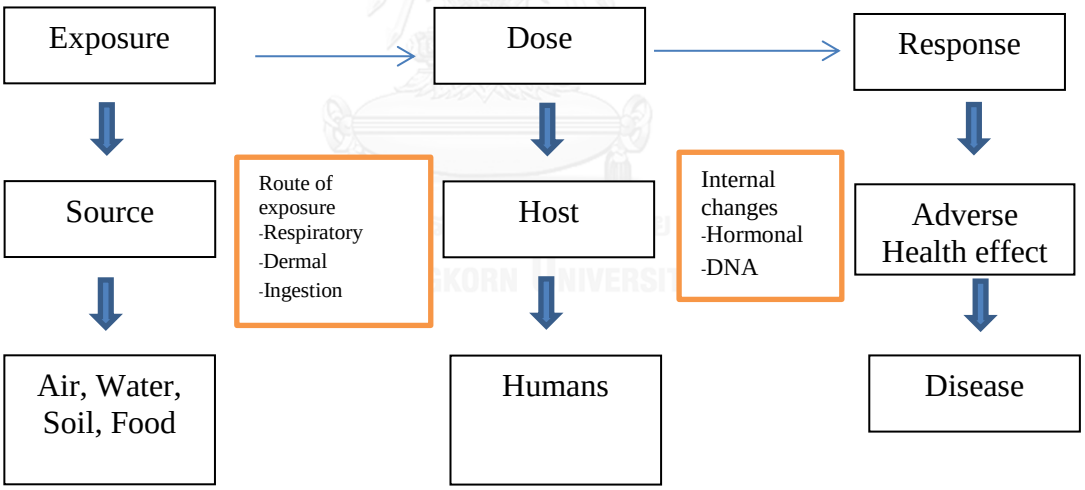
$$E = \int_{t2}^{t1} C(t)dt$$

E =intensity of exposure

$C_{(t)}$ = exposure concentration

t2-t1 = duration of exposure

Furthermore, there have had a variable that influence the exposure and dose are physiological factors such as age, gender, physical condition, human behavior and activities such as work time each day, pattern of contact and contact rate such as how much drink water.



Source adapted from (Samet and Jaakkola**, 1994**)

Figure 2.3 Source of exposure, dose and biological effects that lead to human disease

2.3.1 Source and emissions

There are many harmful or pollution source, it can device two source; natural source such as volcanic outbreak , storm, flooding and human activities such as industrial ,transportation, energy production. The human activities source is the main source which difference and variety type of emission sources, for example point sources

such as industries process, activities that releasing pollutants to air or water, line-sources such as road, power –lines, area sources such as farm and agriculture landfills. Pollution sources are releasing pollutant to air or water in many form such as particulate, liquid, mist, fume, gas, and vapor. In the public health workers, source of exposure to highly hazardous chemicals are during handling, mixing, application use and contaminate clothing is a significant of exposure (WHO &UNEP,2006)

2.3.2 Transportation, Transformation and fate

Environmental transformation describes a chemical's lifetime in the environment until it is converted to substances naturally found in the environment, or until its fate can be described in some other way. Environmental transformation is highly dependent on the medium. In air, transformation is by abiotic chemical reactions; in soil and water, biodegradation may predominate. Substances that persist in the environment will build to higher concentrations and may be more widely distributed. The pollutants have several factors such as volatilization, temperature, humidity which pollutants can transported to environmental condition over short or long distances. For example, the benzene' chemical property is high vapor pressure and volatile substance, so it can be moved throughout the atmosphere and air movement.

2.3.3 Exposure pathways and routes of exposure

Exposure pathways is referred to as the process which a pollutants exists from the source of chemical or agent to human bodies exposure.

Exposure route is referred to as the way of harmful environmental condition factors such as chemical, biological, physical agent enters to human bodies. There have the three major exposure routes to human are Inhalation, ingestion and dermal contact.

Respiratory inhalation and dermal contact is the main route exposures to chemical and pesticides workers (Damalas, 2011).Dowling reported that workers which respiratory exposure were usually occur when using highly volatile pesticide and working with no respiratory personal protective equipment or working condition

is poorly ventilation(Dowling, 2002)..Dermal contact occur when workers are direct skin contact with chemical or clothing and tools that are contaminated with chemical.(Sanborn, 2002). Dermal exposure and ingestion are related to systematic inflammation or sensitization when workers were exposed with high concentration of chemical at the workplace (Maestrelli, 2009).

2.3.4 Dose (Organization & (WHO), 2001).

Dose is referred as "the amount of a pollutant that may enter the body is usually only part of the exposure and is referred to as the dose" Dose can divided three term are absorbed dose(internal dose),target organ dose and biological effect dose

- *Absorbed dose*(internal dose) is referred as "the amount of an agent that can passes into a tissue or organ over the time"

- *Target organ dose* is referred as " the integrated concentration of the agent in the target organ, that is the organ where the particular agent may cause an adverse health effect"

-*Biological effectdose* is referred as "the intergraded quantity after subtraction of non-contributing fraction of dose or biotransformed proportion of substance that may cause an adverse health effect"

2.3.5 Toxicokinetics

Toxicokinetics describe the process how human body arrange a chemical, in term of ADME are chemical **A**bsorption, **D**istribution, **M**etabolism and **E**xcretion that reaches the target organs and tissue. After chemical entering to body via inhalation (lung), dermal contract (skin) or ingestion track. Toxicity is affected in one or more tissue or organs. For example, mixture pesticide with diesel fuel, affect the central nervous system such as dizziness, loss of coordination, headaches, nausea, asphyxiation , lung damage, and cause irritate the skin and can lead to redness ,pain and chemical burn blisters (Lagorio S, 2009);(Peters S, 2013)). When chemical is transported to the site of action target organs. The chemical is usually dissolved and

reached to blood system, activated at targets organs, eliminated by detoxification mechanism and excrete in urine, bile or sweat. The excretion substances in urine and blood usually used biological monitor for estimation the quantity exposure or dose in term of chemical occupational exposure and used to the medical surveillance program.

- **Urine**, occupational health staff is usually used urine samples in biologicalprogram because they are simple to collect media in large volume and workers is harass from sampling. However urine sampling is limited in case of kidney failure, if the glomerular filtration rate (GFR) is decease, the quantity for eliminating toxic substance also decreases.(Organization(WHO), 2001).
- **Blood,** chemicals or substances are transported via the blood and reached todifferent tissues or organs where they are stored, accumulated or metabolized after that tissues will be released to blood once again. The blood concentration of chemical is depended by the exposure concentration and concentration in the tissues. (WHO, 2001)

2.3.6 The relationship between exposure or dose and health effect

Researcher suggested that exposure assessment is used to determining causation of disease. When exposure and dose increase, health effect or response will usually have more increase and a great number of human may be affected.(SB, 1965). There were two definitions in term of the relationship between exposure or dose and health effect, *exposure- effect relationship*is referred to the relationship between exposure and effect and *dose-effect relationship* is referred to the relationship between dose and severity or type of effect

Elinder studied relationship between dose and prevalent in percent(response) , relationship expressed dose or exposure increases due to the prevalence of individuals of minor dysfunction, minor effects and major effects (Elinder C-G, 1994).

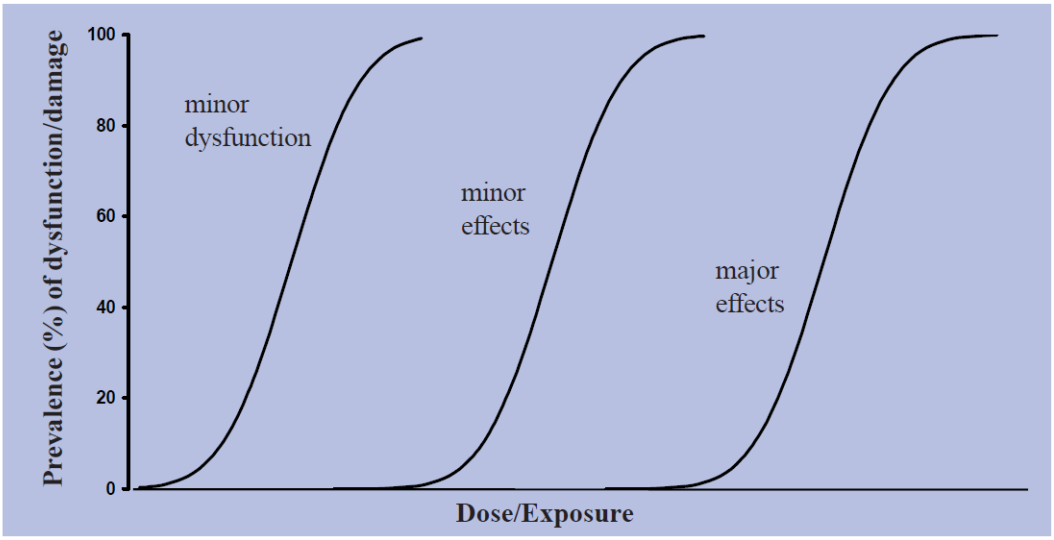


Figure 2. 4 relationship between dose and the prevalent in percent(response) (Elinder et al ,1994)

Another studied the association between benzene exposure and leukemia among cohort workers who exposure to benzene in united states. The results showed that the standardized mortality ratios for leukemia increased when workers were exposed benzene increased(Robert A. Rinsky & Young, 1987). The relationship between benzene exposure and leukemia show in Table 2.1

*Table 2.**1 Relationship between benzene exposure and mortality ratios of leukemia.*

Benzene exposure concentration (ppm)	The standardized mortality ratios(Persons-year)
Less than 40	109 to 322
41 to 199	323 to 1186
200 to 400	1187 to 6637
More 400	more 6637

2.3.7 The scope of exposure assessment (WHO, 2001)

The purpose of occupational exposure assessment is to identify environmental condition exposure as chemical, physical, and biological agent that may lead to health effect. The scope of exposure assessment includes:

2.3.7.1 Identification and evaluation of source, hazardous of agent (type, amount chemical release, location)

2.3.7.2 Determination of chemical concentrations in environmental media such as air, water, food and soil.

2.3.7.3 Identification of (major) pathway and routes of exposure

2.3.7.4 Duration, frequency and intensity of exposure

2.3.7.5 Health effect from exposure

2.3.8 Factors should be consideration of exposure assessment

WHO (2001) described factors that researcher must be considerations of human exposure assessment as follow

2.3.8.1 Exposure duration and frequency are estimated of total exposure. In term epidemiological studies can divided two pattern exposure are short periods and long periods. For short periods (minutes, hours or days) exposure is often averaged the specific time exposure periods. Epidemiological studies, cumulative exposure is usually used to estimate of total average exposure intensity as the exposure index, especially in occupational exposure assessment(Semple, 2005).

$$\mathrm{CE} = \sum_{1}^{n} E \times t$$

Where CE is the cumulative exposure (ppm.years or mg.days/m3)
E is the exposureintensity for a given job, task or event
t is the duration of that exposure.

Dobrev conducted the toxicological interactions at occupational exposure levels(threshold limit value/time-weighted average (TLV/TWA)(Dobrev I, 2002).

$$\mathrm{TWA} = \frac{\sum_{i=1}^{n} c_1 t_1}{\sum_{i=1}^{n} t_i}$$

where TLV/TWA = threshold limit value/time-weighted average
Ci = concentration duration the i^{th} interval
ti = duration the i^{th} interval

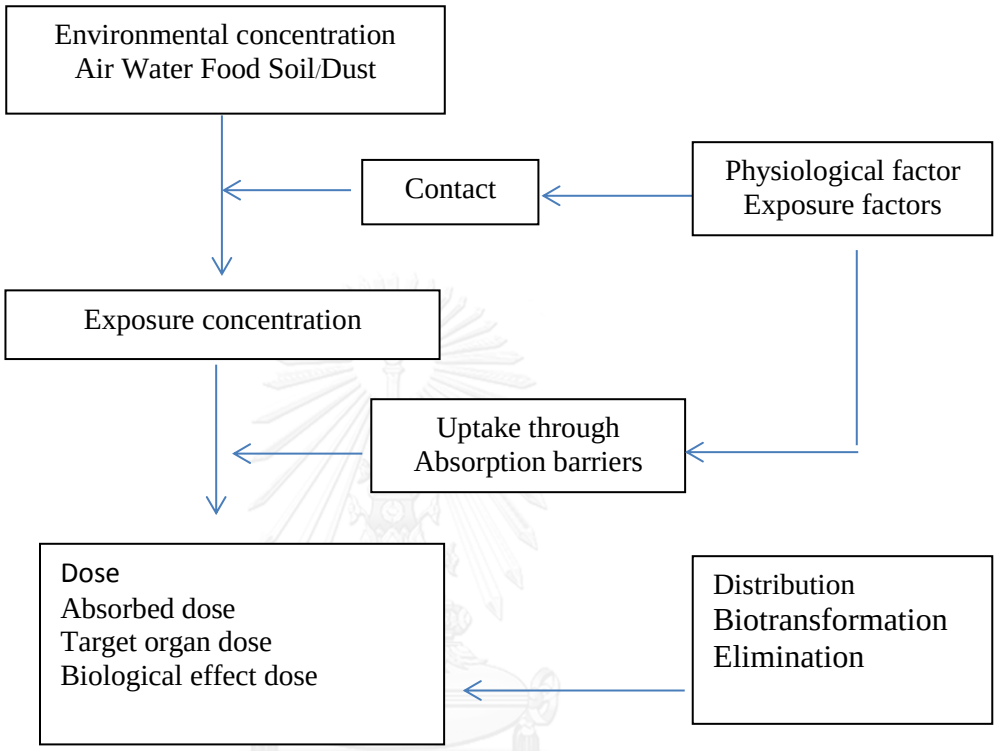


Figure 2.5 The relationship of environmental concentration, exposure concentration and dose (WHO, 2001)

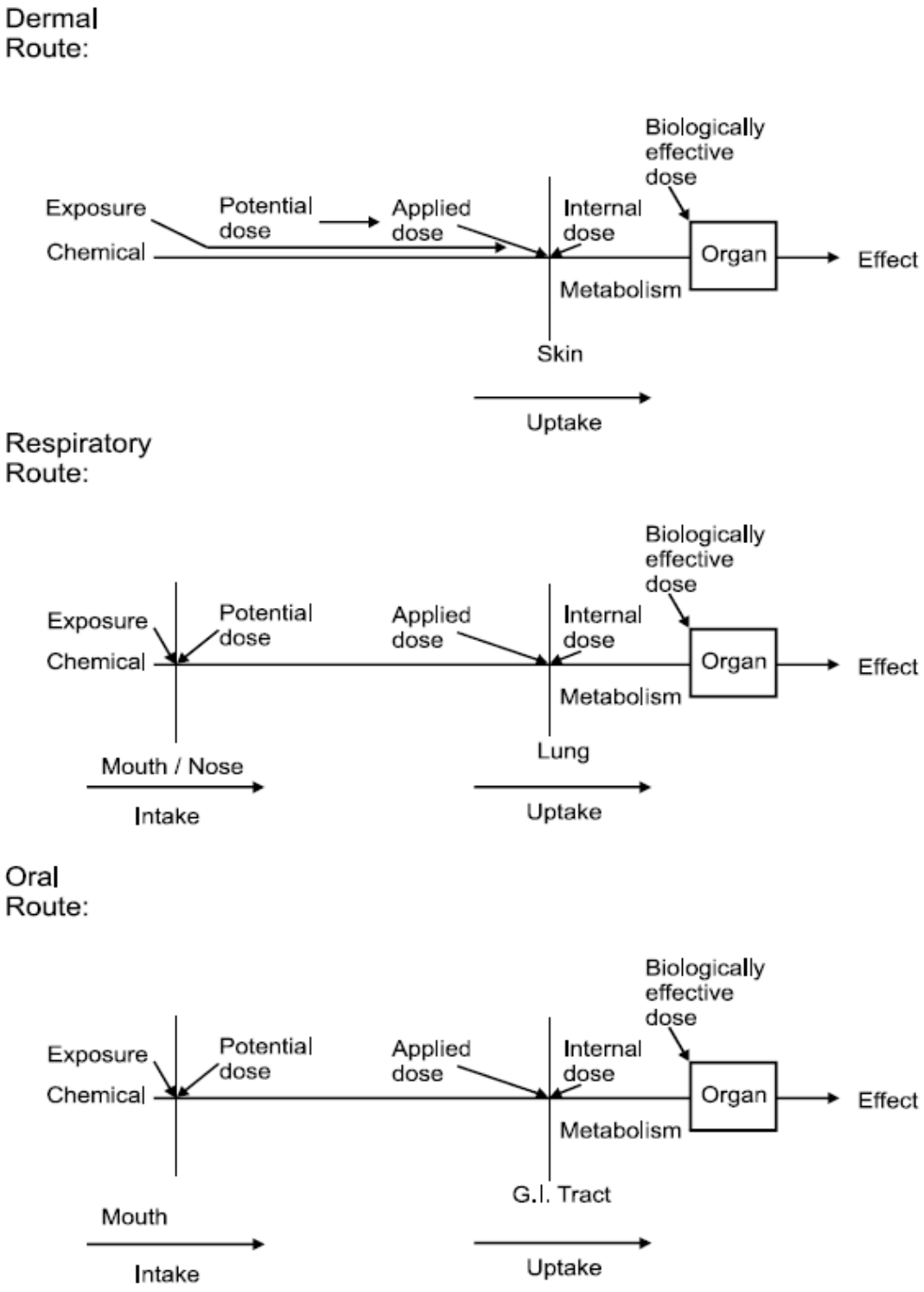


Figure 2. 6 Schematic of dose and exposure(United States Environmental Protection Agency(US EPA), 1992))

2.4 Pesticide formulations and equipment

World Health Organization (WHO) recommended the guideline of chemical methods for the control of vectors and pets of public health importance, pesticide formulations should be concerned when active ingredient is mixed with pesticide with various other ingredients to create pesticide formulations for several purpose use such as enhance stability, low toxicity and improve more efficiency control(Organization(WHO), 1997). Different formulations are showed in Table 2-2

Table 2.2 Chemical formulations mixing for vectors and pets control

Formulations	Used to control
Dustable Powder(DP) and Granule(GR)	-Mixing active ingredient the with inert carrier for using to control mosquito larvae
Emulsificable Concentration (EC)	- Mixing active ingredient plus emulsifier and solvent for pesticide deposit on surface treat, usually strong smell and skin irritation.
Emulsion oil-in-water(EW)	- Mixing active ingredient dissolved solvent and surfactant for using to long period and low level concentration pesticide treat.
Solution(S)	Mixing active ingredient with solvent or fuel oil using for kill adult mosquito ,solution are usually prepared weight per volume (W/V) basis

Source adapted from WHO guideline ofchemical methods for the control of vectors(Organization(WHO), 1997)

Thermal foggers (power operated) are widely used in many counties for vectors control program such as dengue and west nile control program because these machine are highly generated visible fog which is provided more psychological effect to vectors operators and people to see vectors control process. However, thermal fogges are less efficiency than Ultra Low Volume (ULV), the drop size are larger and wide range. Moreover, thermal fog is potential fire hazard when operators are carried pulse jet to indoor or confine space as present Figure 7. Aerosol generators or Ultra Low Volume sprayers (ULV), this machine are mixed or diluted active ingredient with solvent, fuel oil and generated a smaller drop size less (15-25 microns) than thermal foggers which can cover large area. However, operators who are used these machine is calibration for accuracy drop size. Therefore operators or supervisor must be trained maintenances machine and safety operation as present Figure 2.7 and 2.8

Figure 2. 7 Thermal foggers used (Section of Disease control, 2014)

Figure 2. 8 Ultra Low Volume sprayers (Pyranha Inc, 2014)

2.5 Background information of BTEX

BTEX is the abbreviation used for chemical name of petroleum products which consist of benzene, toluene, ethylbenzene, and xylenes. Petroleum products such as diesel fuel and gasoline are usually found BTEX component by weight of 11% Benzene, 26 % Toluene, 11% Ethyl benzene and 52 % Xylene respectively. This study use background chemical safety and health information of ATSDR- Toxicological profile in regard to chemical and physical property, toxicokinetic and health effect (ATSDR,2000; ATSDR,2004)

2.5.1 Benzene

2.5.1.1 Chemical and physical property

Benzene is a clear liquid with sweet odor, volatile organic compounds(VCs) in gas state and high flammable. It occurs naturally but is primarily produced from petroleum products and usually found in the part of crude oil, gasoline and cigarette. Benzene is widely used as a solvent in synthetic materials and makes consumer products such as dyes, insecticides, rubber, nylons, plastic, paints, resins and cosmetics products (ATSDR,2007a)

The physical and chemical property is shown as table below.

Table 2.3 Chemical and physical properties of Benzene

Property	Information
Chemical name	Benzene
Chemical formula	C6H6
Chemical structure	
Molecular weight	78.11
Color	Clear, colorless liquid
Physical state	colorless to light yellow liquid
Melting point	5.5 °C
Boiling point	80.1 °C
Density at 15 °C, g/cm3	0.8787
Odor	Aromatic
Odor threshold	

-Water	2.0 mg/L
-Air	Detection range: 34-119 ppm (geometric mean: 61 ppm) Recognition: 97 ppm
Solubility	
Water at 25 °C w/w	0.188%
Organic solvents	Alcohol, chloroform, ether, carbon disulfide, acetone, oils, carbon, tetrachloride, glacial acetic acid
Vapor pressure at 20 °C	75 mm
Auto ignition temperature	498 °C
NFPA hazard classification	Health 2.2 ,Flammability 3.3Reactivity 0.0
Flammability limits in air	1.2% (lower limit; upper limit 7.8%)

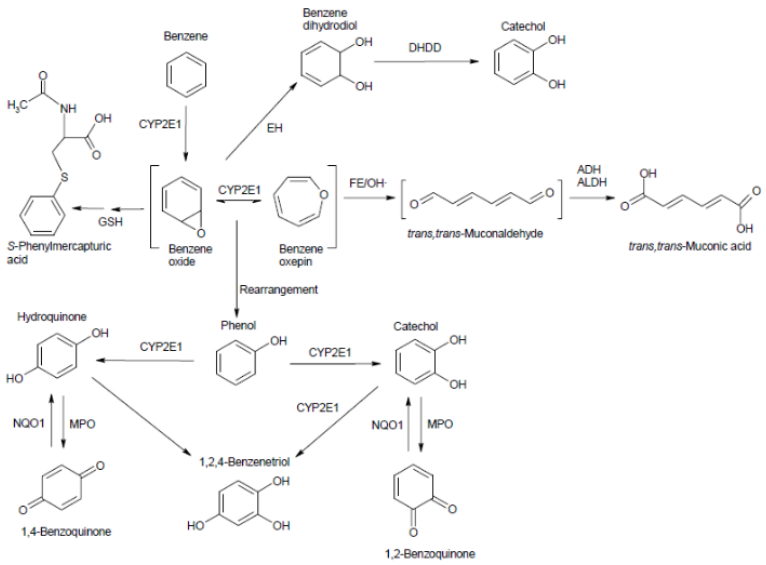
Source: Adapted from toxicology profile of Benzene (ATSDR, 2007a)

2.5.1.2 Toxicokinetic

The most common benzene exposure is both occupational and environmental exposures setting, the main route of Benzene exposure is inhalation but dermal contact is most often only a minor source of exposure. In human, absorption by inhalation ranges from 70 to 80% in the first 5 minutes and is rapidly distributed to accumulate target organs. In case of human high exposure concentration, Benzene were found in the brain and lower concentration levels can found in the fat, blood, kidneys, and liver.

Metabolism of Benzene occurs in the liver. The first step is the formation of benzene oxide, an epoxide by cytochrome P-450 dependent mixed function oxidases. There are two metabolic pathways proceeding from this intermediate. The first process is transformed hydroxylation of the epoxide to phenol which is excreted as a glucuronide or sulfate conjugate, or converted to hydroquinone and

benzoquinone. Phenol, hydroquinone glucuronide and hydroquinone sulfate serve as markers for this enzymatic pathway. The second pathway is related conversion of benzene oxide to muconic dialdehyde through an NADPH mediated process, and further conversion to muconic acid. Catechol is produced via this pathway through the intermediate benzene glycol, and is excreted as a glucuronide or sulfate conjugate (ATSDR, 2007a)



Source : Toxicology profile of Benzene (ATSDR, 2007a)

Figure 2. 9 Metabolism partway of Benzene

2.5.1.3 Health effect

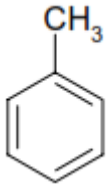
Acute exposure to high concentrations of benzene in air cause neurological toxicity such as headache, dizziness, drowsiness, confusion, tremors, and loss of consciousness and respiratory tract effect such as sensitize the myocardium to endogenous catecholamines. Acute ingestion of benzene causes gastrointestinal and neurological toxicity. Chronic exposure to benzene results primarily in hematotoxicity, including aplastic anemia, pancytopenia, or any combination of anemia, leukopenia, and thrombocytopenia. Chronic benzene exposure is associated with an increased risk of leukemia (ATSDR, 2007a)

2.5.2 Toluene

2.5.2.1 Chemical and physical property

Toluene is a clear, colorless liquid with a distinctive smell. It is found naturally in crude oil and the process of production gasoline and other fuels from crude oil and making coke from coal. Toluene is used in adhesives, fingernail polish, lacquers, making paints, paint thinners, rubber and in some printing and leather tanning processes.

Table 2. ***4 Chemical and physical properties of Toluene***

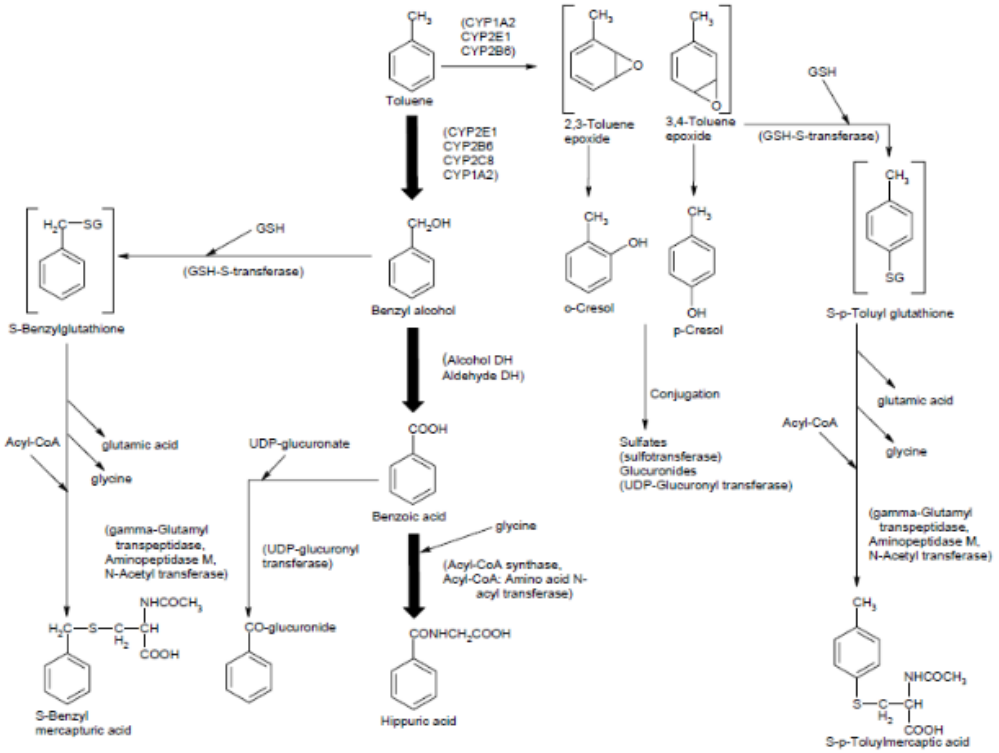
Property	Information
Chemical name	Toluene
Chemical formula	C6H5CH3
Chemical structure	
Molecular weight	92.14
Color	Colorless
Physical state	Liquid
Melting point	-95 °C
Boiling point	110.6° C
Density at 20 °C, g/cm3	0.8669 g/mL
Odor	Benzene-like
Odor threshold	
-Water	0.04–1 ppm
-Air	8 ppm
Solubility	
Water at 25 C w/w	534.8 mg/L
Organic solvents	Miscible
Vapor pressure at 25 °C	28.4 mm/Hg
Autoignition temperature	480 °C
Flammability limits in air	1.2–7.1%

Source: Adapted from toxicology profile of toluene (ATSDR, 2000).

2.5.2.2 Toxicokinetic

The primary route Toluene exposure is inhalation which is rapidly absorbed while toluene is slowly absorbed by skin. Toluene has usually been found in the brain, lung, liver and blood.

The primary steps of Toluene metabolism, cytochrome 450 (CYP) ribozyme catalyze hydroxylation to form benzyl alcohol. Then CYP2E1 catalyze oxidation to benzoic acid. Next, the most of benzoic acid link with glycine to form hippuric acid but some part benzoic acid conjugate with UDP-glucoronate to form the acyl –gucoronide. In human, around 75-80 % of inhalation of Toluene can be transform as hippuric acid and accumulate in urine. Toluene is rapid excrete from the body within 12 hours.



Source Toxicology profile of toluene (ATSDR, 2000).

Figure 2.10 Metabolism partway of Toluene

2.5.2.3 Health effect

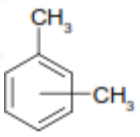
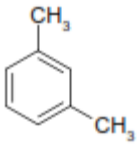
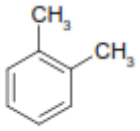
Acute exposure via inhalation cause central nervous system effect such as ataxia, fatigue, sedation, seizures and anesthesia, respiratory effect such as acute bronchitis, bronchospasm, pulmonary edema, pneumonitis, and asphyxia, eye irritation symptom such as burning, conjunctivitis, corneal edema, and corneal abrasions. Ingestion may cause vomiting, abdominal cramps, and diarrhea (ATSDR, 2000).

2.5.3 Xylene

2.5.3.1 Chemical and physical property of Xylene

Xylene has three forms consist of meta-xylene, ortho-xylene, and para-xylene (m-, o-, and p-xylene). it is a colorless, sweet-smelling liquid which high flammable can cause fire easily. Xylene is used as a solvent and in the printing, rubber, leather industries, thinner for paint and varnishes. It is also found in gasoline (ATSDR, 2000b).

Table 2. ***5 Chemical and physical properties of Xylene***

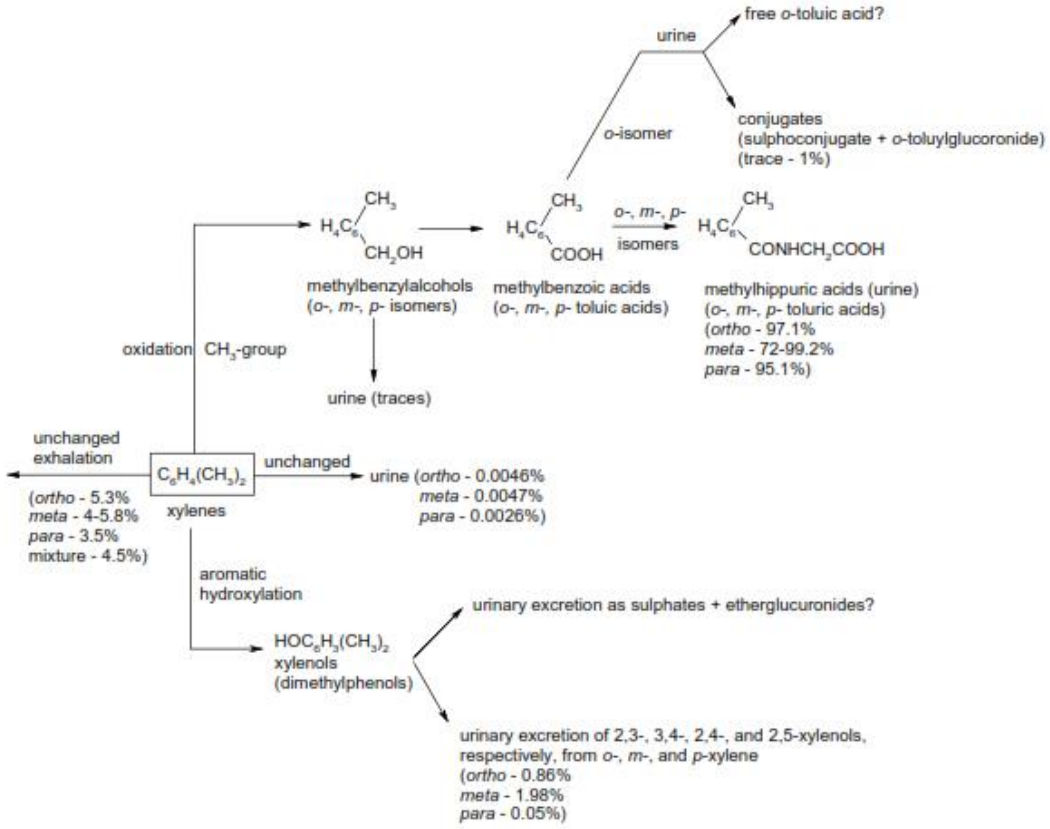
Property	Information		
Chemical name	*m*-Xylene	*o*-Xylene	*p*-Xylene
Chemical formula	C8H10	C8H10	C8H10
Chemical structure			
Molecular weight	106.16	106.16	106.16
Color	Colorless	Colorless	Colorless
Physical state	Liquid	Liquid	Liquid
Melting point	-47.8 °C	-25.2 °c	13.2 °c
Boiling point	139.1 °C	144.5 ° C	138.4 ° C
Density at 20 °C, g/cm3	0.864 g/m3	0.880 g/m3	0.8611 g/cm3
Odor	Sweet	sweet	sweet
Odor threshold			
-Water	No data	No data	No data
-Air	0.05 ppm	0.05 ppm	0.05 ppm
Solubility			
Water at 25 C w/w	161 mg/l	178 mg/l	162 mg/l
Organic solvents			

Vapor pressure at 25 °C	Miscible with alcohol, ether, and other solvents	Miscible with alcohol, ether, and other solvents	Soluble in alcohol, ether, and other organic solvents
Auto ignition temperature	527 °C	463 °C	528 °C
Flammability limits in air	1.1-7.0%	1.0-7.0%	1.1-7.0%

Source: Adapted from toxicology profile of Xylene (ATSDR, 2000b).

2.5.3.2 Toxicokinetic

In humans, the primarily metabolism of xylene proceeds by the oxidation of a side-chain methyl group by microsomal enzymes (mixed function oxidases) in the liver to form toluic acids (methyl benzoic acids). These toluic acids conjugate with glycine to form toluic acids (methylhippuric acids) that are excreted into the urine. Minor metabolic is elimination of unchanged compound in the exhaled breath and in the urine, and the urinary elimination of methylbenzyl alcohols, *o*-toluylglucuronides (*o*-toluic acid glucuronide), xylene mercapturic acid and xylenols (dimethylphenols) Metabolism of the various xylene isomers in humans is shown in Figure 2.11



Source Toxicology profile of Xylene (ATSDR, 2000b).

Figure 2. 11 Metabolism partway of Xylene in Human

2.5.3.3 Health effect

Respiratory Effects. In humans, nose and throat irritation has been reported when exposure to mixed xylene at 200 ppm for 3–5 minutes, *m*-xylene at 50 ppm for 2 hours, and *p*-xylene at 100 ppm for 1–7.5 hours/day for 5 days .However, no increase in reports of nose and throat irritation. Xylene cause decreased forced vital capacity (FVC), increased forced expiratory flow at 75% FVC (FEF), and increased ratio of forced expiratory volume in 1 minute (FEV1) to forced vital capacity (FEV1/FVC) (ATSDR, 2000b).

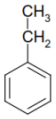
Gastrointestinal Effects. Symptoms of nausea, vomiting, nausea and gastric discomfort have been noted in workers exposed to xylene vapors (ATSDR, 2000b).

2.5.4 Ethyl benzene

2.5.4.1 Chemical and physical property of Ethyl benzene

Ethyl benzene is a colorless liquid and aromatic hydrocarbon in gas state with aromatic odor. It found in petroleum production and is a part of fuel. Vapor gas are heavier than air and cause flash back of fire by vapor move to ignition source. Ethyl benzene is used to produce synthetic rubber. Chemical and physical is presented in Table 2.6

Table 2. ***6 Chemical and physical of Ethyl benzene***

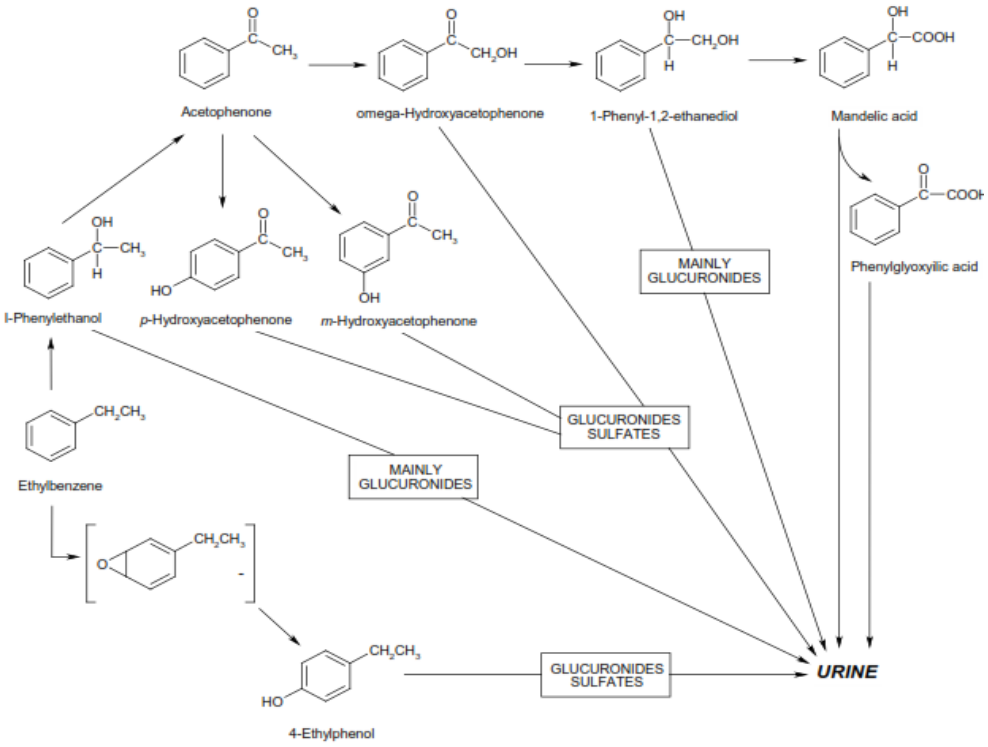
Property	Information
Chemical name	Ethylbenzene
Chemical formula	C8H10
Chemical structure	
Molecular weight	106.17
Color	Colorless
Physical state	Liquid
Melting point	-94.975 °C
Boiling point	136.19 °C
Density at 20 °C, g/cm3	0.8670
Odor	Sweet, gasoline-like
Odor threshold	
-Water	0.029 mg/L
-Air	2.3 ppm
Solubility	
Water at 25 C w/w	177 mg/L

Organic solvents	Miscible with usual organic solvents Soluble in alcohol and ether
Vapor pressure at 25 °C	9.53 mm Hg
Autoignition temperature	810 °F (432 °C)
Flammability limits in air	0.8 (lower) vol% –6.7 (upper) vol%

Source: Adapted from toxicology profile of Ethyl benzene (ATSDR, 2010).

2.5.4.2 Toxicokinetics

Inhalation is the main route exposure, the major metabolite of Ethyl benzene are mandelic acid and phenylglyoxylic acid. The first step of metabolite partway is hydroxylation at the side chain Ethyl benzene to form 1-phenylethanol by cytochrome P-450. Then 1-phenylethanol is linked to glucuronide which ether excrete or change metabolite. Result of 1-phenylethanol hydroxylation is acetophenone which excreted in the urine and further transformed. Next continued oxidation at side chain result in 2- hydroxyacetophenone, 1- phenyl- 1,2- ethynediol, mandelic acid, and phenylglyoxylic acid respectively . Other metabolite partway is glucuronide and sulfate link to hydroxylated to produce glucuronides and sulfates that are excrete in urine. Therefore biomarker in urine due to Ethyl benzene exposure via inhalation is mandelic acid, and phenylglyoxylic acid.



Source Toxicology profile of Ethyl benzene (ATSDR, 2010).

Figure 2 12 Metabolism partway of Ethyl benzene in Human

2.5.4.3 Health effect

There have several studies were reported that occupational exposure to Ethyl benzene cause respiratory tract and ocular irritation and possible hearing loss. Exposure to high concentration via inhalation can cause throat irritation, dizziness((ATSDR), 2010) (ATSDR,2010). Ethyl benzene has classified by IARC as group 2B possible carcinogenic to human(Cancer(IARC), 2012).

2.6 BTEX exposure monitoring

2.5.1 Direct method (Active sampling)

The methodologies for BTEX (Benzene, Toluene, Ethyl benzene and Xylene) inhalation exposure can measured by direct method, samples of air contaminant are collected by using personal sampling pump in breathing

zone. Workplace air contaminant is drawn air through a charcoal adsorbent tube with different flow rate and duration sampling which depend on type of chemical, there are showing in table 4. Next, BTEX in workplace air samples is analyzed by gas chromatography with flame ionization detection (GC-FID) (Health(NIOSH), 2003b).

Table 2. 7 ***Sampling flow rate, volume, capacity, range, overall and accuracy***

Substance	Sampling Flowrate (L/min)	Sampling Volume[b] (L) MIN	Sampling Volume[b] (L) MAX	Breakthrough Volume @ Concentration (L)	Breakthrough Volume @ Concentration (mg/m³)	Range at VOL-MIN (mg/m³)	Overall Bias (%)	Overall Precision ($\hat{S}_{rT}$)	Accuracy (±%)
benzene	≤0.20	5	30	>45	149	42 - 165	-0.4	0.059	11.4
p-tert-butyltoluene	≤0.20	1	29	44	112	29 - 119	-10.3	0.071[c]	20.7
cumene	≤0.20	1	30	>45	480	120 - 480	5.6	0.059	15.2
ethylbenzene	≤0.20	1	24	35	917	222 - 884	-7.6	0.089[c]	17.1
α-methylstyrene	≤0.20	1	30	>45	940	236 - 943	-7.6	0.061[c]	16.9
β-methylstyrene	≤0.20	1	30	>45	940	236 - 943	-7.6	0.061	16.9
toluene	≤0.20	1	8	12	2294	548 - 2190	1.6	0.052	10.9
xylene (o-,m-,p-)	≤0.20	2	23	35	870	218 - 870	-1.2	0.060	12.2
styrene	≤1.00	1	14	21	1710	426 - 1710	-7.9	0.058[c]	16.7

[a] Minimum recommended flow is 0.01 L/min.
[b] V_{Min} = minimum sample volume @ OSHA TWA;
V_{Max} = maximum sample volume @ OSHA TWA
[c] Corrected value, calculated from data in Reference 5.

Source: NIOSH Manual of Analytical Methods 1501 (Health(NIOSH), 2003b)

Generally, sampling technical reason, air contaminant in environmental working condition cannot be sampling in a work full shift, because workers are vary exposed deepening activities and duration exposure. However, researchers are collected in a group of events or action of consecutive sampling periods. Estimation of total occupational exposure is reported of as the time-weighted average concentration (TWA) and be compared with occupational exposure standards such as Threshold Limit Values (TLV) or Max Allowable Concentration (MAC values)((ACGIH), 2007).

2.5.2 Biological monitoring (Biomarkers of exposure)

Biological monitoring can assess amount of chemical substances from body metabolites or derivatives in tissues, excrete. Biological monitoring is more important and accuracy method for evaluation of occupational exposure to aromatic hydrocarbon or v such as benzene, toluene, Xylene (Heinrich et al.,2000). The metabolite processes of Human body are inter- individual differences due to varied route of exposure, absorption, metabolism and excretion. American Conference of Government Industrial Hygienist (ACGIS) and Ministry of Labor, Thailand were recommended the biological exposure indices standard for BTEX biological monitoring((ACGIH) , 2007);(Labor, 2007).

Table 2. 8 Biological exposure indices standard for BTEX

Parameter	Benzene	Toluene	Ethyl benzene	Xylene
ACGIHBEIs(2007)	-TT-Muconic in urine, End of Shift(EOS)500 ug/g Cr. -S-phylnylmercapturic acid in urine25 ug/g Cr.	Hipuric in urine End of Shift 1.6 g/g Cr. O-cresol in urine End of Shift 0.5 mg/l	-	Methyl hipuric acid End of Shift(EOS) 1.5 g/g Cr.
Ministry of Labor, Thailand (2007)	-TT-Muconic in urine, End of Shift(EOS)500 ug/g Cr. -S-phylnylmercapturic acid in urineEnd of Shift(EOS)25 ug/g Cr.	Hipuric in urine End of Shift 1.6 g/g Cr.O-cresol in urineEnd of Shift0.5 mg/l	Mandelic in urine End of week(EOW) 1.5 g/g Cr.	Methyl hipuric acid End of Shift(EOS) 1.5 g/g Cr.

Source: Biological exposure indices standard for BTEX biological monitoring (ACGIH,2007,Ministry of Labor,2007).

Sampling and analytical forexposure to toluene , xylene and ethyl benzene (hipuricacid,methylhipuric and madelic acid) were conducted by NIOSH method 8301 (Health), 2003a), benzene(TT-muconic acid) analyze by using high performance liquid chromatography (HPLC)(Scherer, (1998)

2.5.3 Questionnaires

Questionnaires can analyze risk factor and information on relevant occupational exposure such as time, activity patterns, source of exposure , characteristics of participants. Furthermore, questionnaires can be used to categories exposure and Rezazadeh and co- workers who studied occupational exposure of petroleum depot workers to BTEX Compounds, researchers used questionnaires to assess BTEX exposure such as age, sex, nutritional habits, smoking, drug consumption and use of personal protective equipment(RezazadehAzari, 2012). When researchers interview participants, researchers should be used standard questionnaires that have been tested and validated. If questionnaires cannot validate, the studied should be provide reliability of questionnaires (Armstrong BK, 1992).

2.7 Pulmonary function test

2.7.1 What is Pulmonary function test?

Pulmonary or lung function test is physical test by using spirometer to measure person inhales and exhales volume of air as function of time for evaluate how well the lung work. This test is used to access the cause respiratory problem (Miller, 2005)

Lung function test measure

1) The quantity of air(liters) that person can inhale into lung. This amount is compared with reference people by age, height, and sex.
2) The amount of air (liters) that person can exhales from lung and how fast they can do it

2.7.2 What is parameter for evaluate pulmonary function test ?

Miller explained the parameter and definition for standardization of spirometry as list below

1.) **FVC** (Forced vital capacity)

FVC is refer "the maximal volume of air exhaled with maximally effort from a maximal inspiration with presented in litres at body temperature and ambient pressure saturated".

2.) **FEV1** is "the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in liters at BTPS"

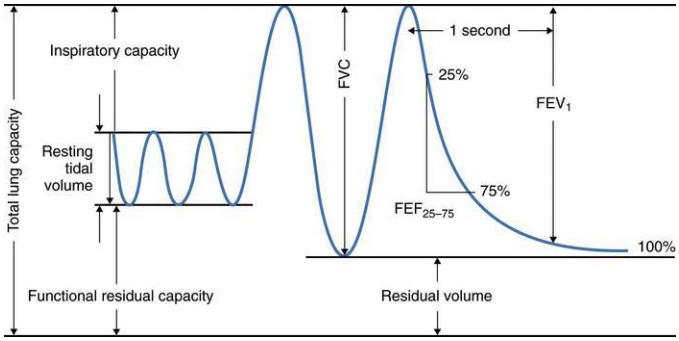
3.) **FEV1/ FVC** is "the comparison between the maximal volume of air exhaled in the first second with the maximal volume of air exhaled" It is used to consider lung obstruction (% FEV1/ FVCis less than 70 %)

4.) **FEF25–75%** is "the mean forced expiratory flow between 25% and 75% of the FVC (FEF 25–75%) " or the maximum mid-expiratory flow.

5.) **PEF** is mean "peak expiratory flow: The highest forced expiratory flow measured with a peak flow meter"

6.) **VC** is "Vital capacity: the volume of air breathed out after the deepest inhalation".

7.) **IVC** is "Inspiratory vital capacity: the maximum volume of air inhaled from the point of maximum expiration Inspiratory vital capacity: the maximum volume of air inhaled from the point of maximum expiration"



Source Adapted from spirometry test(Miller, 2005)

Figure 2 13 Graph spirometry test

2.7.3 Procedure of pulmonary function test

Pulmonary function test and quality control of this study will follow the guideline of Thoracic Society of Thailand under Royal Patronage (2012) and Standardisation of spirometry (Miller, 2005)

1) Participants properness

Participants is interviewed and physical tested by occupational medicine. If the results of medical examination show participants have been cataract surgery, participants will exclude of this study.

2) Explanation and Demonstration

Occupation health physicians explain and demonstrate about process of pulmonary function test as follow

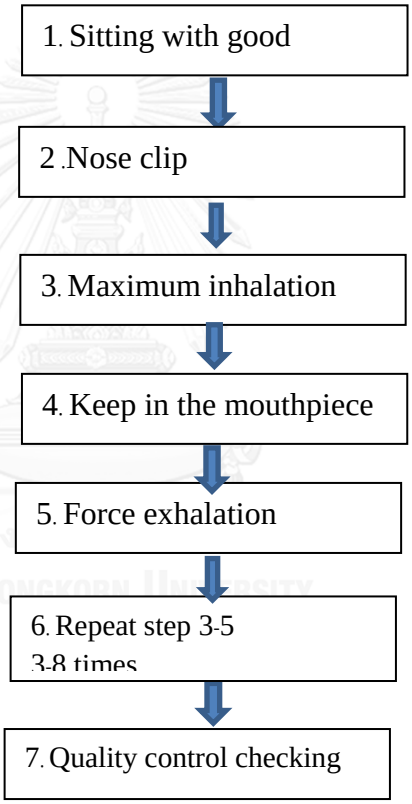


Figure 2 14 process of pulmonary function

3) Pulmonary function test and interpreting

Pulmonary function test will perform by Occupation health physicians and occupational medicine will interpret data

4) Quality control checking, we consider acceptability criteria

and reproducibility criteria

Acceptability criteria

Occupation health physician will check inhalation and exhalation of participants by consideration volume and time, acceptability criteria the extrapolate volume should less than 5% FVC or 0.15 liter and time of force exhalation should at least 6 second

Reproducibility criteria

Occupation health physician select 3 graph that pass acceptability criteria

-The difference data of maximum value of FVC and second maximum value of FVC are not over 200 milliliter

-The difference data of maximum value of FEV_1 and second maximum value of FEV_1 are not over 200 milliliter

2.8 The Health Belief Model

In 1950, Irwin Rosenstock, Godfrey Hochbaum and Stephen Kegels developed the health belief model to explore a variety of health behavior over short and long term. The principle of The Health Belief Model is provide six constructs health information such as perceived susceptibility ,perceive severity, perceived benefit , perceived barrier ,cure to action and self-efficacy activate people for prevent disease

- Perceived susceptibility refer is belief in the chance of getting condition
- Perceive severity is belief in the seriousness of condition and its consequence.
- Perceived benefit is belief in the effectiveness of suggested action to reduce the risk or impact
- Perceived barrier is belief in the tangible and psychological cost of the advised action

- Cue to action is belief in the strategies to activate one's people to take action
- Self-efficacy is belief in the confidence one's ability to take action

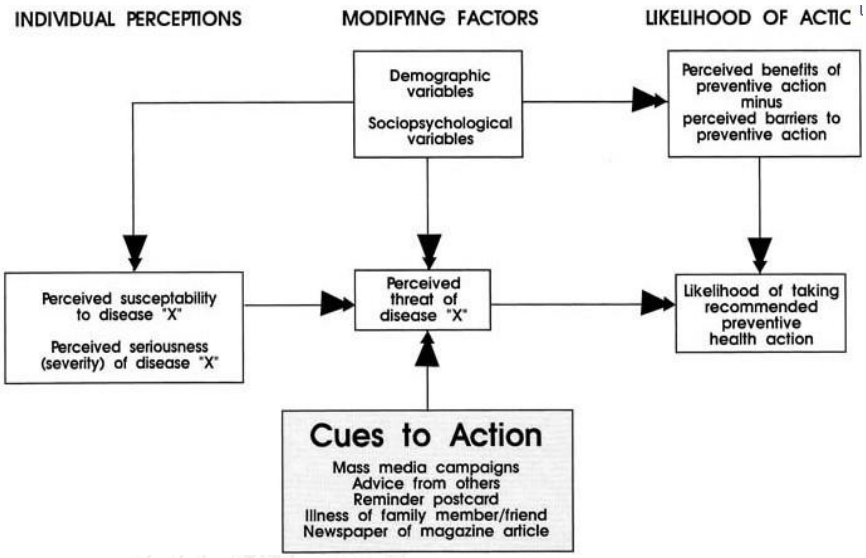


Figure 2.15 The Health Belief Model Framework
Source : Blinkhorn (1999)

2.9 Relate articles

Boogaard (1995)studied comparison of s phenyl mercapturic acid, trans,trans-muconic acid, and phenol for benzene exposure of workers. The results found trans,trans-muconic acid is suitable for bio monitoring to benzene exposure as concentrations of benzene are higher than 1 ppm (8 h TWA). However, trans,trans-muconic acid was usually detected in urine of workers who are smoking.

Loonsumrong (2012) was carried out to assessed BTEX inhalation exposure and identified health risk assessment due to BTEX exposure among workers at car parking. Breathing air samples were absorbed by using activated charcoal tube and analyzed gas chromatography which sampling and analytical method are followed NIOSH 1501. Bio monitoring were conducted by collect urine at end of shift. Results found the mean concentration of BTEX exposure were 11.28±(5.03) , 56.13±(73.96),

7.16±(9.19),10.58±(6.32) ug/m^3 respectively. Health risk assessment from benzene exposure. Cancer risk was estimate 4.37 x 10^{-6} which indicated workers have developing at risk cancer. Biomarker concentration in urine of workers, t,t-Muconic acid, hipuric acid and methyl hipuric was not correlation BTEX exposure of worker. However, researcher found increasing of ethyl benzene concentration was associated with upper respiration symptom (cough).

Kongtip (2013) assessed occupational exposure to Malathion and Bifenthrin in 54 volunteer of mosquito control sprayers by dermal contract. Pesticide were collected by using cotton patches smeared on skin and urine samples were also collected. The results found that the 3-(2-chloro-3, 3, 3-trifluoro-1-propenyl)-2, 2-dimethyl-cyclopropanecarboxylic (TFP) acid level was significant difference before and after work. A 59.3 % of participants had health symptoms after 1-3 hours of pesticide spraying were skin and upper respiratory irritation(75%),dizziness-nausea (59.4%) headache, short breathing, chest tightness and numbness respectively. Participants should use plastic protective clothing, nylon or polyester to protect pesticides from skin contact.

Navasumrit et al. (2005) conducted environmental and occupational exposure to benzene in Thailand. Ambient and personal air samples and t,t-muconic acid in urine were collected and analyzed by NIOSH method. Results found mean concentration of benzene at gas station and petrochemical factories were 64.78 ppb and 66.24 ppb respectively. Benzene exposure of workers were significantly increased t,t-muconic acid in urine.

Tunsaringkarn (2012) estimated hazard quotients and life time cancer risk among 49 participants who were worked at 6 gasoline stations in the inner and outer areas of Bangkok. Air samples at near gas station and roadside were collected by activated charcoal tube and analyzed by gas chromatography with flame ionized detector (GC-FID). Furthermore participants were interviewed by using occupational health questionnaire to find out symptoms workers. Results showed hazard quotients for BTEX were 0.600, 0.008, 0.007 and 0.002, respectively. The life time cancer risk to

benzene and ethyl benzene of workers were estimated at $1.75\times10^{-4}$and 9.55×10. Workers were working at gas station and exposed BTEX would increase risk of cancer. Moreover, this study found that benzene and toluene exposure can cause of fatigue workers.

Priyadarshini G (2014) carried out 60 petrol pump elderly workers who age 30-60 years with working more than 1 year and exposure to toxic substances from petrol and diesel. The workers were accessed pulmonary function by spirometer. Results of FVC, FEV_1, $FEF_{25.75\%}$ were significantly decline. Especially FVC/FEV_1 was significant decline in elderly workers in age 50-60 years. Elderly workers were had at risk benzene exposure and other health harmful substances. The measure for prevention chronic disease, elderly workers should be early recognition hazard, job rotation and remove from workplace.

CHAPTER III

RESERCH METHODOLOGY

3.1 Study Design

This study was conducted a quasi-experimental study to assessed current exposure to diesel exhaust and cypermethrin, as measured by daily duration of spraying, number of years of spraying, chemical exposure, investigate the relations of chemical occupational exposures and health effect and find out the effectiveness of chemical safety training program intend to reduce pesticide and chemical occupational exposure among vector control operators in Bangkok, Thailand. One hundred and twenty-six participants were purposive selected by using questionnaire from six Bangkok administration areas. Participants were recruited to wear personal air sampling, collected urine samples at the end of shift and interviewed participants with questionnaire to find out history exposure, behavior, health status and health symptoms and lung function test. Data collection were conducted during winter, summer and raining season to consider for season differences in exposure pattern of operators.

3.2 Study Area

This study was conducted in six administrative areas in Bangkok—Central Bangkok, South Bangkok, North Bangkok, East Bangkok, North Khungthon, and South Khungthon. Ninety-six male (18–60 years) public health VCOs were recruited and met the inclusion criteria. There were 48 operators in the intervention group from North Bangkok, South Bangkok, and East Bangkok and 48 operators in control group from North Khongthon, South Klongthon, and Central Bangkok.

3.3 Sample Size Calculation

The sample size calculation is based on Wang et al. (2007),who studied the relationship between urinary pesticide metabolites and pest control operation among occupational pesticide sprayers. They found that the mean and standard deviation concentration of 3- phenoxylbenzoic acid (3-PBA) in the urine of the exposure group was 9.6 (2.5) nmol/g of creatinine and in the non-exposure group was 7.7 (1.9) nmol/g of creatinine. The sample size was calculated by using a **sample size for a comparative study of two population means: continuous outcomes** with 80% power, beta 0.35, and 95% confidence level(Hajian-Tilaki, 2011). Thus, this study required a sample size of at least 30 participants in each group plus an additional 10% of the total participants to account for sample withdrawal.

$\mathbf{Z}_{\alpha/2} = \mathbf{z}_{\alpha} = 1.96,\ \mathbf{z}_{\beta} = 0.85\ ,\ \sigma_1 = 2.5^2, \sigma_2 = 1.9^2,\ \Delta = 1.9$ ug/ml

$n/group = \frac{2(\mathbf{z}_{\alpha/2} + \mathbf{z}_{\beta})^2 \sigma_1^2}{\Delta^2}$ *(Daniel, 1999; Lemeshow et al.1990)*

$n/group = \frac{2(1.96+0.85)^2 (0.9^2)}{1.9^2}$

$= 27$

sample loss 10% ~ 3

$n/group = 30$

The total number of vector control workers in Bangkok have 126 workers, so to prevent sample losses and bias from exposure misclassification, this study will be sampling all workers. However, VCOs were only participated 103 operators and passed inclusion criteria 96 operators for questionnaire study and 68 for lung function study. See Figure 17.

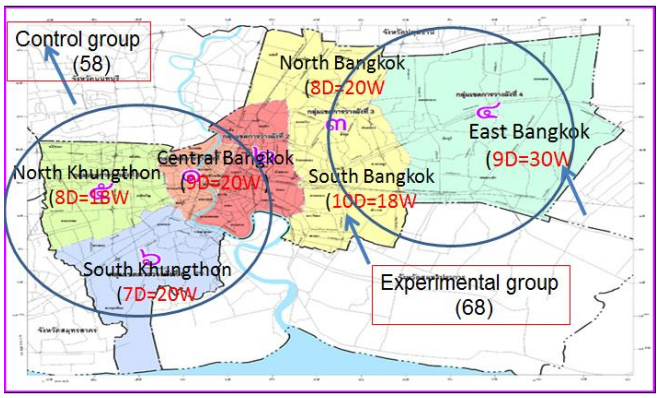


Figure 3. 1Study area

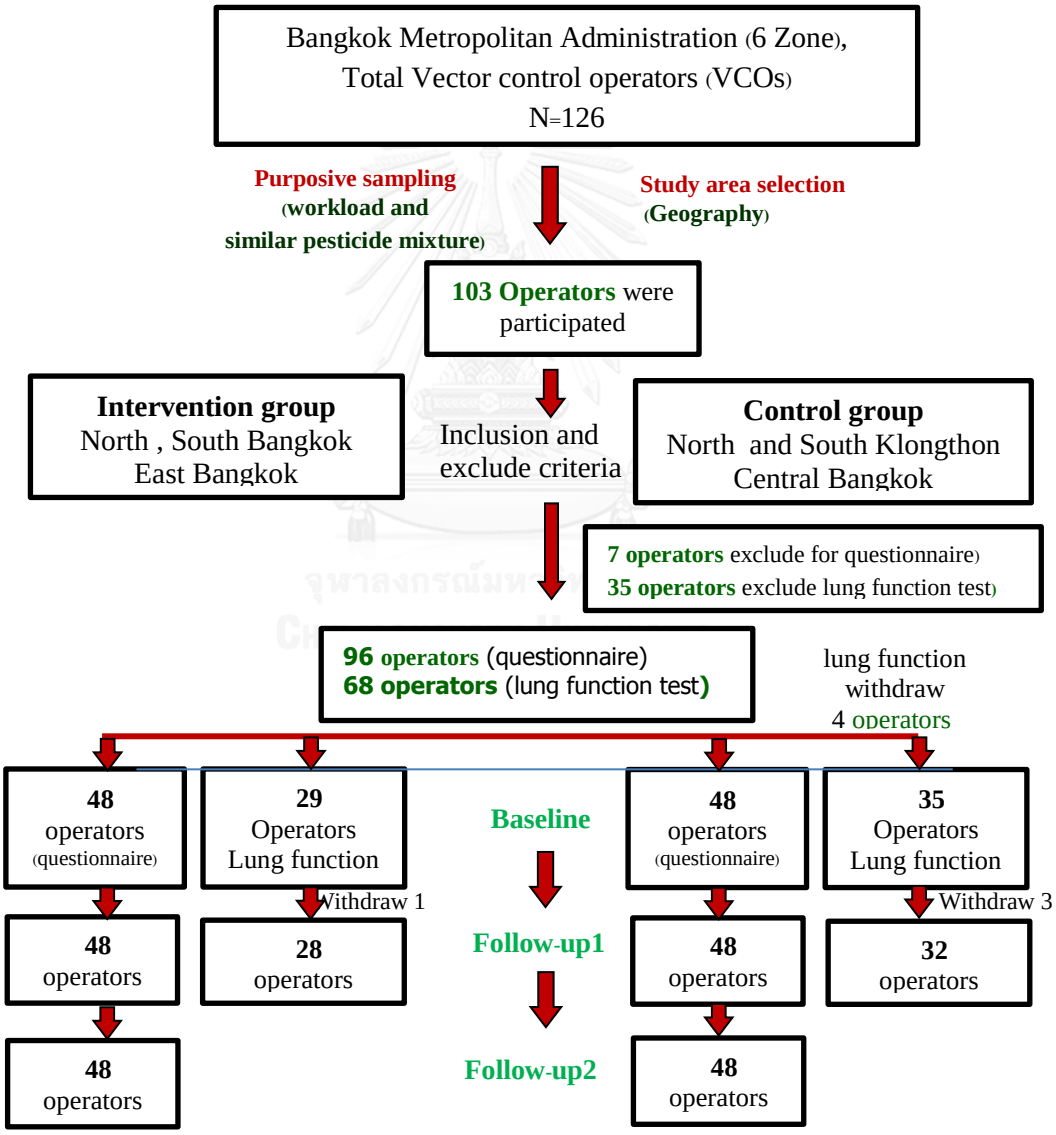


Figure 3. 2 Sampling technique flowchart

3.4 Study Population

Participants who volunteers agree to participate and inform consent. Questionnaire-based information were interviewed on work history and health status, occupational, drinking and smoking habits and working conditions. The participants were between age 18-60 years who are all healthy and have not been suffering from respiratory disorders.

Inclusion criteria

- Working or at least 6 months in BMA employee (8 hrs. per days or 40hours per week)
- Voluntary to participate
- Male age 18- 60 years
- Use thermal fogging spraying

Exclusion criteria

- Having history of respiratory disease such as asthma, emphysema ,hearth disease
- Rotation job work shift

3.5 Data Collection

Prior data collection, participants who participated and volunteer to this study to inform consent procedures for each subject which approved from the college of Public Health Sciences, Chulalongkorn University ethical consideration board. Each participant was obtained information about objective of study, data collection and the benefit which participants received from this study. Data collection procedure were conducted 12 months which cover winter, summer and raining seasons.it is dividing into four phases: preparation, baseline, intervention and evaluation phase.

3.5.1 Preparation phase

(1) Discussed and presented a project, objective and procedure of this study with head of environmental and sanitation section, environment health.

2) Recruit voluntary participants by interviewed on work historical and health status, occupational, drinking, smoking habit and following inform consent.

3) Design questionnaire after review previous studies relate with BTEX personal monitoring. The questionnaires are consisting four parts: 1) general demographic information, 2) working condition characteristic 3) occupational health symptom and 4) safety behavior

Part 1: General demographic information will be interview about demographic information such as age, sex, weight, high, smoking behavior.

Part 2: Working condition characteristic be interview about job activity and time, personal protective use, time spent of transportation, use of and exposure to organic solvents at home

Part 3: Occupational health symptom via inhalation and skin exposure: troth irritation, eyes irritation, nose irritation, fatigue, dizziness, headache, cough, nausea, confusion, drowsiness.

Part 4: Safety behavior consist 15 items (Appendix A): read chemical label, staff explain chemical hazard, use expired, use mouth open pesticide container, mix and spray pesticide, personal hygiene (drinking, smoking at workplace, take a shower, change clothing, wash hand), store pesticide and disposal in safe area.

(4)Test accuracy of questionnaire about index of item objective congruence(IOC) by three experts and test reliability of questionnaire by collection 30 vector control workers and analyze questionnaire by using Kuder-Richardson -20(KR-20).

3.5.2 Baseline phase.

(1) Participants were interviewed by using questionnaire and have a check-up health status by occupational medicine.

(2) Personal BTEX sampling

- Air sampling technique was follow NIOSH Method 1501, breathing air is draw into SKC activated charcoal tube 50/100 mg by personal sampling pump with air flow rate 0.2 litter per minute at least 2 hrs. and record job activity and time.

- Transportation, after sampling a activated charcoal tube is sealed with plastic cap then put in plastic bag and storage in with keep temperature under-10 c

- Sample preparation and analysis is follow Figure 18

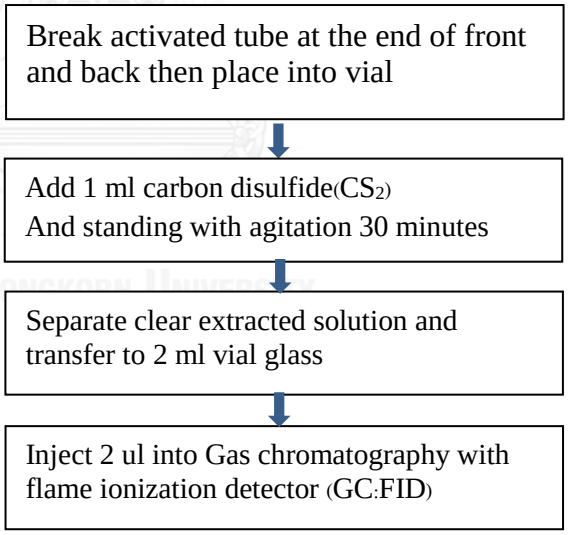


Figure 3.3 Sample preparation and analysis

- Sample analysis, sample analytical technique is followed by NIOSH Analytical Method 1501 as follow Table 2.7

(3) Quality control for airborne

3.1 Limit of detection (LOD) and limit of quantitation (LOQ). Analyzed benzene and toluene standard solution at 0.5 ug/l 3 times and calculate LOD and LOQ by

$$LOD = 3SD$$
$$LOQ = 10\ SD$$

3.2 % Relative Standard deviation (%RSD) calculated by

$$\%RSD = \frac{SD \times 100}{X}$$

3.3 % Recovery at 20, 60 and 100 ug/l

% Recovery = ((concentration (add standard solution) - concentration (no add standard solution)) / concentration (add standard solution

3.4 R^2 between Peak area and concentration at 20, 40, 60, 80, 100 ug/l

Table 3.1 Gas chromatography condition

GC Model	*Perkin – Elmer* ATD 400
Carrie gas	Helium (make up) 30 ml/min Hydrogen 32 ml/min Oxygen 305 ml/min
Capillary column	Helium
Flow rate of Helium	1 ml/min
Injection Method	Spiltless
Injection volume	2 ul
Injection temperature	150 ºC
Detector type	Flame ionization detector
Detector temperature	250 ºC
Oven temperature	150 ºC
Oven condition	Temp 40ºChold 2 min to 100 ºC, At rate 10 ºC/min

Table 3.2 Quality control results of Gas chromatography

Air borne	LOQ	LOD	%RSD	%Recovery	R^2
Benzene	0.5	1.5	5.37	92-107	0.998
Toluene	0.6	2.2	6..41	91-106	0.998
Cypermetrin	0.05	0.15	6.22	101-125	0.998

(3) Biological monitoring

3.1 Urine samples each participant was collected at the end of shift (EOS) and end of week (EOW) and transfer into 10 ml polystyrene tube with keep temperature -10 c. The chemical metabolite in urine will determine by using difference method as follow Table 3.3

Table 3.3 Biological monitoring method

Parameter	Biological exposure Index	Analytical Technique	Method
Benzene	-TT-Muconic in urine, EOS 500 ug/g Cr.	High performance liquid chromatography(HPLC)	Scherer(1998)
Toluene	Hipuric in urine, EOS 1.6 g/g Cr.	High performance liquid chromatography(HPLC)	NIOSH 8301(2003)
Cypermethrin	3 phenoxybenzoic acid(3-PBA), EOS	High performance liquid chromatography(HPLC)	(Thiphom et al., 2014)

Note EOS End of shift

3.2 Biological analysis and quality control

3 PBA analysis methods were modified from Thiphom and Prapamontol's method by using high-performance liquid chromatography (HPLC) – Agilent 1260, column Luna 5u C18(2) 100 A 150 x4.6 mm, flow rate 0.8 ml/min, mobile phase water:acetonitrile 40:60, inject volume 20 ul at 25ºC 210 nm (14). Then 100 uL sodium hydroxide (6N) was added to the plasma and heated up to 100ºC for an hour. After cooling, 1 ml of 0.2 sodium acetate buffer (pH 4.5) was added to adjust pH to

around 12, and 2 ml of ethyl acetate was added and shaken for 10 minutes to clean up the samples. Then the remaining aqueous phase was combined with 120 uL hydrochloric acid (6N) to reduce pH to around 3, and evaporated in nitrogen steam. The residue sample was dissolved in 200 uL of methanol and 2 ml of sodium acetate buffer was added to adjust pH to 5 and solid phase extraction (SPE) cartridge was used to reduce matrix effect from hydrolyzed urine. A 3 PBA analysis was conducted in the central analysis laboratory of the Faculty of Public Health of Mahidol University. The analyzer had a 3-PBA detection limit of 0.05 μg/ml and, LOQ 0.15 ug/ml, % recovery 85-106 and %RSD 6.5-7.7, respectively.

Trans, trans-muconic acid (tt-MA) and o-cresol

The Scherer method and NIOSH 8301 methods were used to determine the level of trans-Muconic acid and o-cresol benzene and toluene exposure, respectively (Scherer,1998; NIOSH,2003). Urine samples were collected into 10 ml-polystyrene tubes at the end of the work shift and kept at -20ºC until transported for analysis. For the determination of tt-MA and o-cresol by using high performance liquid chromatography (HPLC -DAD 1260 Agilent , column C18 250 mm 5 μ, Mobile phase : Acetic acid + Methanol + phosphate buffer (10 mL + 100 + 10) total 1000 mL), flow 1.5 mL/min, briefly, 100 uL sodium hydroxide (6N) was added in 1 ml urine and extracted with 1.5 ml ethyl acetate. The residue was evaporated in nitrogen steam and dissolved with 0.5 ml mobile phase (10 ml acetic acid + 100 ml methanol + 10 ml phosphate buffer). The tt-MA was analyzed at the toxicology laboratory of the Ramathibodi Hospital of Mahidol University which has a limit of detection (LOD) and limit of quantification (LOQ) for tt-MA at 10 ug/ml and 70 ug/ml, % recovery at 200 ug/l 93% and 800 ug/L 101%, % RSD 6.5% at 200 ug/l and 5.8% at 800 ug/l and for o-cresol had LOD 0.02 mg/L and 0.07 mg/L, % recovery at 0.15mg/L 90 % and1.0 mg /L 98 %, % RSD 6.5% at 0.15 mg/L 3.6% and 1.0 mg /L 2%, respectively. The quantities of metabolite concentration were used after adjusting for urine creatinine concentration.

Table 3. 4 Quality control results of high-performance liquid chromatography (HPLC) for biological exposure analysis

Metabolite	LOQ	LOD	%RSD	%Recovery	R^2
3 PBA	0.05 (ug/ml)	0.15 (ug/ml)	6.5-7.7	85-106	0.998
tt-MA	10 ug/ml	10 ug/ml	5.8-6.5	93-101	0.998
O-cresol	0.02 mg/L	0.07 mg/L	3.6-6.5	90-98	0.998

(4) Pulmonary function test

Pulmonary function test and quality control of this study will follow the guideline of Thoracic Society of Thailand under Royal Patronage (2012) and Standardisation of spirometry (Miller et al;2005)

5) Participants properness

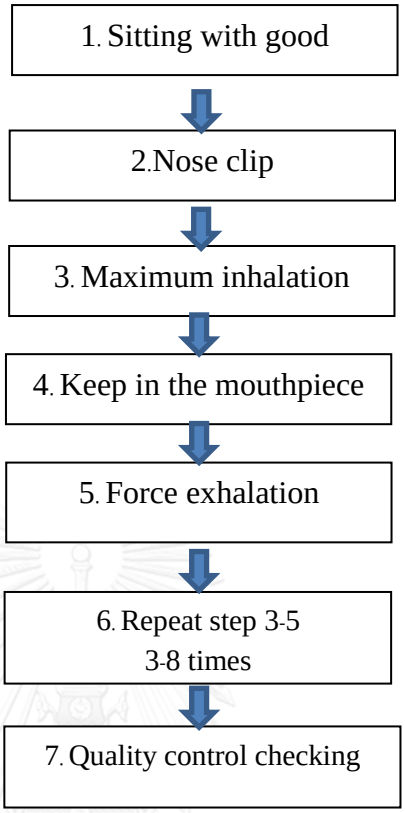
Participants is interviewed and physical tested by occupational medicine. If the results of medical examination show participants have been cataract surgery, participants will exclude of this study.

6) Explanation and Demonstration

Occupation health physicians explain and demonstrate about process of pulmonary function test as follow

7) Pulmonary function test and interpreting

Pulmonary function test will perform by Occupation health physicians and occupational medicine which perform as follow Figure 19



***Source**: Thoracic Society of Thailand under Royal Patronage (2012) and Standardizations of spirometry (Miller et al;2005)*

Figure 3. 4 process of pulmonary function test

8) Quality control checking, we consider acceptability criteria and reproducibility criteria

Acceptability criteria

Occupation health physician will check inhalation and exhalation of participants by consideration volume and time, acceptability criteria the extrapolate volume should less than 5% FVC or 0.15 liter and time of force exhalation should at least 6 second

Reproducibility criteria

Occupation health physician select 3 graph that pass acceptabilitycriteria

-The difference data of maximum value of FVC and second maximum value of FVC are not over 200 milliliter

-The difference data of maximum value of FEV_1 and second maximum value of FEV_1 are not over 200 milliliter

3.5.3 Intervention phase

This study integrated the principle of safety chemical program with health belief model. The intervention program consists of chemical safety training, field practice (PPE use, chemical safety handling and occupation medicine examination and consulting. The process of Intervention phase is following.

(1) Meeting the local head of sanitation and environmental district, environmental health staff and vector control workers to explain project, objective, data collection and brainstorming to find collaboration and interaction of stakeholder

(2) Training of basic chemical safety with using motivation technique, give a examples, demonstrate and field practice training (2 days)

(3) Occupation medicine given some consulting about occupational health and symptom due to chemical exposure and recommendation how to prevent disease and symptom.

(4) Providing the proper personal protective equipment such as chemical mask, goggle, hand protection and body.

(5) Chemical mask Fit test training program

(6) Providing CD-ROM of safety chemical program

3.5.4 Evaluation phase

After intervention, this study were conducted to follow up 2 times for estimation the effectiveness intervention program. The evaluation phase consist of 4 categories are following

(1) Assessing safety behavior such as personal protective equipment use, chemical safety practice by using questionnaire of HBM scale (5 point Likert scale: always done, often done, sometime done, rare done and never done)(Raksanum, 2012).

Given high score if VCOs had safety behavior done, incontrast, low score for unsafely behavior done.

(2) Interviewed vector control operators by using questionnaire to find health symptom due to chemical occupational exposure

(3) Pulmonary function test.

(4) Evaluation chemical exposure by sampling.

-BTEX personal sampling.

-Biological monitoring in urine after end of work spraying

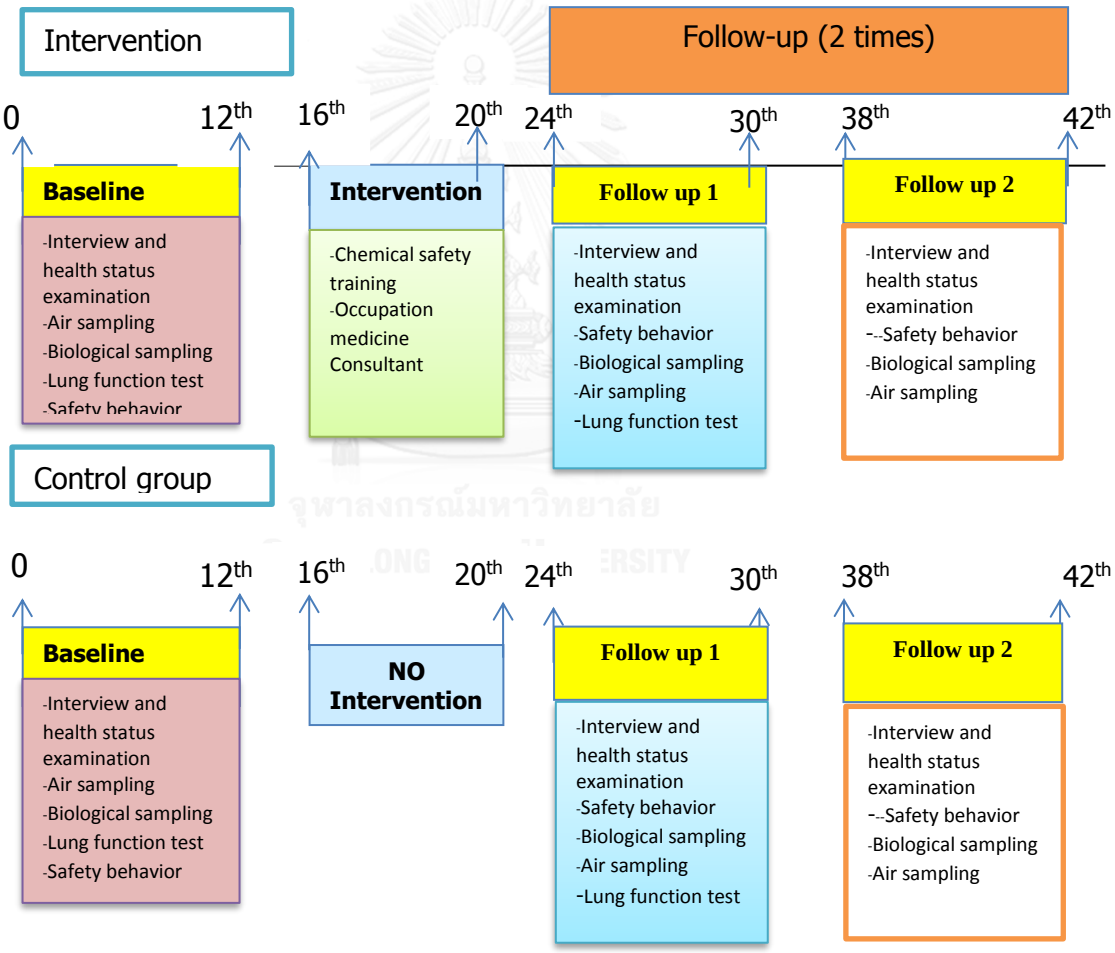


Figure 3.5Data collection schedule

3.6 Data analysis

This study used the license SPSS version 17 of Chulalongkorn university to data analysis for answer research question as following.

3.6.1 Baseline characteristic of participants

-Descriptive statistics measures in term of mean (standard deviation), median, range, frequency and percentage use to analyze participants demographic and baseline outcome variables : current exposure to diesel exhaust and cypermethrin as measured by environmental monitoring and biological monitoring ,current health situation among these operators, as measured by symptom prevalence, prevalence of underlying illnesses, and spirometric lung function

1) continuous variables : means, standard deviation and range
2) categorical variables: frequency and percentage

-Comparison significant differences between intervention group and control group of general characteristics of workers is follow

1) Independent T-test to test for socio-demographics occupational Characteristic for mean scores for risk factors such as age, working environment concentration, Work year of experience(continuous variables)
2) Chi square to test for accident injury history, systematic illness, work/task characteristics (categorical variables).

3.6.2 To answer research question.

-*What is the current relationship (before intervention) of the workers' health situation with their occupational chemical exposure from spraying*?

1) Multiple linear regression to analyze the . association between the environmental monitoring, biological monitoring, personal and working conditions (independent variables) and workers' health (dependent variables)

-Bivariate was tested for analysis of each outcome in relation to each independent variable.

-A semi-final multiple logistic model was constructed in each independent variable for which p 0.2 in bivariate analysis was used. -

-Final logistic regression models were analyzed, including environmental monitoring, biological monitoring factors, and personal and working conditions for which p 0.2 was used in the semi-final multiple logistic models. Statistical significance was designated at p 0.05.

- *Is a chemical safety intervention, intended to reduce the operators' spraying-related chemical exposure, followed by reduction in this exposure?*

1) Linear mixed model to test estimate the differences for the continuous dependent variables(outcome) is the mean of biological marker in urine concentration
2) Repeated –measures ANOVA to test intervention program for summarize the effect of the intervention across time

-*Is the intervention followed by improvement in the operators' health situation?*

1) Generalized linear models (genlin) to test estimate the differences for the dichotomous variables (outcome) is the mean of worker' symptom.
2) Repeated –measures ANOVA to test intervention program for summarize the effect of the intervention across time
3) Pair-t test will test difference of mean lung function test: FVC,FEV_1FVC /FEV_1 (pre and post intervention)

-*Is a chemical safety intervention, intended to improve safety behavior of pesticide use ?*

1) Linear mixed model and repeated measure ANOVA to test estimate the differences for the continuous dependent variables(outcome) is the mean safety behavior scor

Table 3. 5 Statistic analysis& reasons

Variables Characteristics	Type of measure	Statistic use	Reason
Age	Interval scale	Mean, SD, range T-test	-To describe and compare individual variables characteristic between intervention and control group
Education	Interval scale		
Working experience	Interval scale		
Smoking behavior	Nominal scale	frequency, percentage Chi square	Same reason
PPE use	Nominal scale		
Duration spraying	Interval scale	Mean, SD, range and T-test	Same reason
Chemical exposure concentration	Interval scale		
Outcome measure: Primary out come			
Safety behavior	Continuous	Linear mixed model with repeated-measure ANOVA -COVTYPE(unstructure)	-To make a picture and calculate intervention effects(IE) to see overall effectiveness and general idea intervention effects -Evaluate the intervention program which by comparing mean pre-post differences in outcome between intervention and control group across a Follow-up time.
Biological exposure index in urine	Continuous	Linear mixed model and repeated measure ANOVA	
Symptom of workers	Dichotomous	Generalized linear models and repeated measure ANOVA	
Lung function test: **FVC, FEV_1 FVC /FEV_1**	Continuous	Linear mixed model and repeated measure ANOVA	Same reason

3.7 Ethical Consideration

The VCOs who participated and volunteered to this study were Informed consent procedures for each subject by conducted and approved from the college of Public Health Sciences, Chulalongkorn University (COA No. 172/2558). Before providing the program, the purpose, the benefits and the risks linked to this research will be explained to all the participants.

1) The participants can be requested for any additional information and clarification they need and invited to decide whether they want to participate to the research or not.
2) After accepting to participate, a written informed consent was signed before starting the intervention study.

All the data was kept confidentially except for the further health education or implementation for vector control operators

CHAPTER IV

RESEARCH RESULTS

A quasi-experimental study was conducted in six Bangkok administration areas to determine the effectiveness of safety chemical program to reduce occupational exposure, improve health and safety behavior of pesticide use over 12 months intervention program from October 2015 to October 2016. The study populations were Bangkok public health vector control operators. The effectiveness of the intervention program was done by using standardize questionnaires, collected personal air and urine sampling at baseline, first follow-up session was done in 2nd March 2015 to 3th May 2015 and second follow-up session was done in 2nd July 2016 to 3th October 2016. The study results are presented in 4 parts: (1) general characteristics of participants which consisting socio-demographic characteristics, personal factors, working condition and environmental factors (2) situation of airborne as cypermathrin, benzene and toluene exposure among VCOs (3) occupational risk factors associate with health workers symptoms (4) outcomes of the effectiveness of the effectiveness of safety chemical program.

4.1 General characteristics of participants

A total 96 vector control operators (VCOs) were participated and met inclusion criteria, there are were 48 operators in intervention group from North Bangkok, South Bangkok and East Bangkok and 48 operators in control group from North Klongthon, South Klongthon and Central Bangkok. General characteristics of participants are shown in Table 4.1 Both groups are similar socio-demographic characteristics, all participants were male, average age of intervention group and control group were 42.1

and 41.2 years old, respectively (p=0.74). The average work experience of operators in intervention group and control group were 8.8 and 7.9 years, respectively (p=0.92). There was no significant difference in both groups. See Table 4.1

*Table 4.**1 Socio-demographic characteristics at baseline compare between intervention group and control group (Independent T-test)*

Socio-demographic Characteristics	Total (n=96)		Intervention group (n=48)		Control group (n=48)		*p-value*
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age (years)	41.70	10.20	42.10	10.95	41.42	9.51	0.74
Work experience (years)	11.31	8.35	11.21	8.83	11.40	7.90	0.92

Table 4.2 shows results of the homogeneity of age group, education level, personal factors and environmental, working condition factors and personal protective equipment use. Characteristics were similar in intervention group and control group , most participants had age group between 31 to 40 years, most of them graduated secondary school(p= 0. 050) . Personal factors- number of participants who reported smoking, drinking and preserve food consumption had no significant difference in both group (p=0.089), (p=0.77) and (p=0.112), respectively. Working condition in term of activity of spraying insecticide, mixing insecticide and spraying time were similar in both groups (p=0.452). Duration sprayed insecticides not difference in intervention group and control group (p=0.112) - they usually spray more than 3 hours per day. Most operators are spraying at indoor area were similar in both groups, 58.3 % in intervention group and 60.4 % in control group (p=0.835). Almost all participants reported that they don't use personal protective equipment during working (spraying and mixing), 81.2 % in intervention group and 66.7 % in control group, however there were no significant difference in both group(p=0.162).Often personal protective equipment (PPE) use, most of operators who reported that regularly cotton mask use-72.9 % in intervention group

62.2 % in control group, likewise regularly body clothing use 89.2 % in intervention group 66.6% in control group, It had no significant difference in both group (p=0.066) and (p=0.568), respectively. Whereas most of operators in intervention group and control group who reported that had never been used of chemical mask, goggle, rubber gloves and rubber boots that were similar in both groups. Moreover, fraction of all airborne and metabolite had no significant difference in both group at baseline, follow up1 and follow up2.

Table 4. 2 ***Socio-demographic characteristics at baseline compare between intervention group and control group (chi-square test)***

Socio-demographic characteristics	**Intervention group (n=48) n(%)**	**Control group (n=48) n(%)**	**X^2(df)**	***p-value***
Age group				
<30	9(18.7)	8(16.6)	1.85(3)	0.603
>31-40	8(16.6)	12(25.0)		
>41-50	14(29.1)	16(33.3)		
51>60	17(35.4)	12(25.0)		
Education level				
Primary school	9(18.7)	15(31.2)	7.63(3)	0.050
Secondary school	31(64.5)	18(37.5)		
Diploma	8 (16.6)	15(31.2)		
Smoking				
Don't smoke	10(20.8)	18(37.5)	4.83(1)	0.089
Smoke	36(75.0)	30(62.5)		
Drinking				
Don't drink	7(14.6)	8(16.7)	0.079(1)	0.779
Drink	41(85.4)	40(83.3)		
Preserve Food consumption				
No	31(64.6)	38(79.2)	2.52(1)	0.112
Yes	17(35.4)	10(20.8)		
Indoor spaying				
No	20(41.7)	19(39.6)	0.043	0.835
Yes	28(58.3)	29(60.4)		
Working condition				
Spraying insecticide	40(83.3)	36(75.0)	1.01(1)	0.452
Mixing/loading pesticide	8(16.4)	12(25.0)		
Duration spraying				
<3 hrs/day	19(39.6)	20(41.7)	0.043(1)	0.835
>3 hrs./day	29(60.4)	28(58.3)		
PPE use				
Don't use	39(81.2)	32(66.7)	2.66(1)	0.162
use	9(9.4)	16(33.3)		

Table 4.2 cont. Socio-demographic characteristics at baseline compare between intervention group and control group (chi-square test)

Socio-demographic characteristics	Intervention group (n=48) n(%)	Control group (n=48) n(%)	X^2(df)	*P-value*
Often of chemical mask use				
Never	35(72.9)	28(58.3)	5.23(2)	0.073
Once in a while	11(22.9)	11(22.9)		
Regularly	2(4.1)	9(18.7)		
Often of cotton mask use				
Never	4(8.2)	1(2.0)	5.42(2)	0.066
Once in a while	10(20.8)	4(8.2)		
Regularly	35(72.9)	43(89.5)		
Often of goggle use				
Never	36(75.0)	33(68.7)	0.66(2)	0.719
Once in a while	7(14.5)	10(20.8)		
Regularly	5(10.4)	5(10.4)		
Often wearing rubber gloves				
Never	37(77.1)	29(60.4)	3.77(2)	0.152
Once in a while	10(20.8)	15(31.2)		
Regularly	1(2.2)	4(8.3)		
Often wearing body clothing				
Never	14(29.1)	10(20.8)	1.13(1)	0.568
Once in a while	4(8.3)	6(12.5)		
Regularly	30(62.2)	32(66.6)		
Often wearing rubber boots				
Never	33(68.7)	36(75.0)	2.65(1)	0.265
Once in a while	7(14.5)	9(18.7)		
Regularly	8(16.6)	3(6.2)		

Table 4.2 (cont) ***Socio-demographic characteristics of Fraction airborne and metabolite at baseline, follow up1 and follow up 2 compare between intervention group and control group (Independent T-test)***

Socio-demographic characteristics	Intervention group (n=48) n(%)	Control group (n=48) n(%)	F	*p-value*
Fraction of cypermethrin/3PBA				
Baseline	19.72(5.08)	18.7(4.62)	0.30	0.335
Follow-up1	28.24(21.09)	24.35(9.07)	3.09	0.243
Follow-up2	12.21(1.60)	10.56(4.14)	2.91	0.436
Fraction of benzene/ tt-MA				
Baseline	10.49(2.26)	6.54(4.52)	10.24	0.200
Follow-up1	10.56(7.49)	10.16(4.21)	2.40	0.745
Follow-up2	2.90(0.394)	2.20(0.39)	0.14	0.12
Fraction of toluene/ o-cresol				
Baseline	1.52(0.39)	1.63(0.73)	1.06	0.363
Follow-up1	1.71(0.39)	1.85(0.88)	2.93	0.336
Follow-up2	2.9(0.36)	2.20(0.39)	2.17	0.12

4.2 Situation of cypermathrin, benzene and toluene exposure and chemical metabolite among Bangkok vectors control operators.

Table 4.3 shows the average level of cypermethrin from pesticide exposure among operators was 0.91±0.38 mg/m^{3}or 0.005±0.002 ppm and 3 phenoxy benzoic acid (3 PBA) level which is metabolite of cypermethrin was 5.00±2.42 ug/g creatinine. Exposure level of benzene was 1.28±0.86 mg/m^3 or 0.37±0.26 ppm and trans-trans-muconic acid (tt-MA), its metabolite of benzene in urine was 15.75±7.54 ug/g creatinine. Working exposure level of toluene was 2.28 ±0.57 mg/m^3 or 0.56 ±0.13 ppm from diesel

fuel mixing and o-cresol, its metabolite of toluene was 0.159±0.838 mg/ g creatinine, respectively.

Cypermathrin is not yet established for the occupational exposure limits or threshold limit value (TLV). Exposure level for benzene, operators were exposed concentrations was greater than the National Institute for Occupational Safety and Health (NIOSH) recommendation exposure levels(NIOSH RELs) Ca Time weight average (TWA) 0.1 ppm and exposure level for toluene, operators were exposed was less than OSHA and NIOSH occupational exposure limit, which is setting standard 100 ppm

Table 4.3 Concentration of working chemicals and metabolites among Bangkok vector control operators: VCOs (n=96)

Parameters	Concentration Mean± SD	Standard
Chemicals exposure(airborne)		
Cypermethrin	0.005±0.002 ppm	NO
Benzene	0.37±0.26 ppm	NIOSH REF 0.1 ppm
Toluene	0.06± 0.0 ppm	OSHA 100 ppm
Metabolites (urine)		
3 phenoxylbenzoic acid (3 PBA)	5.00±2.42 ppm	NO
Trans,trans-muconic acid	15.75±7.54 ug/g creatinine	ACGIH(2012) 500 ug/g creatinine
O-cresol	0.159±0.838 mg/g creatinine	ACGIH(2012) 0.30 mg/g creatinine

NIOSH Ref National Institute for Occupational Safety and Health (NIOSH) recommendation
ACGIG American Conference of Government Industrial Hygienist

4.3 Occupational risk factors associate with health workers symptoms

4.3.1 Occupational risk factors associate with health workers symptoms while during working

Table 4.4 shows the results from final multiple logistic regression analysis by enter all independent variables including environmental monitoring, biological monitoring, personal and working condition factors while during working.

Eye and facial irritation symptoms

Results indicated that VCOs expose to cypermethrin were 1 times more likely to facial burning (odds ratio (OR), 1.03; 95% confidence interval (CI) 1.0-0.05. The odds ratio of facial burning was approximately 1.0 times greater for VCOs who found o-cresol in urine

The odds ratio of paresthesia/ tingling or numbness was slightly significant among operators who worked at indoor area or indoor spraying were 0.16 times (OR 0.16; CI 0.04-0.55). In addition, operators who exposed toluene in air while spraying were 1 times more likely to paresthesia/ tingling or numbness.

Operators who exposed benzene in air while spraying were 1 times more likely to itchy/scratchy or eye irritation (OR1.02; CI 1.0-1.04). The odds ratio of itchy/scratchy or eye irritation was approximately 3.0 times (OR 2.52; CI 1.3-5.06) greater for VCOs who found 3 PBA l in urine. Interestingly, operators who worked at indoor area were 1.5 times (OR 1.46, CI 0.52-4.67) more likely to blurred vision. In addition, operators who exposed toluene in air while spraying were 1 times more likely to blurred vision.

Skin symptoms

No significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors and skin symptoms or rash

Muscular symptoms

Results indicated that VCOs who exposed with benzene in air while spraying were 1 times (OR 1.0; CI 1.0-1.012) and did not use PPE regularly were 0.3 times (OR 0.3; CI 0.1-0.8) more likely to fatigue burning, respectively. No significant associations were found between operators exposed to occupational chemicals, biological monitoring personal and working condition factors with muscle weakness

Digestion symptoms

Operators who exposed benzene and toluene in air while spraying were 1 times more likely to nausea (OR 0.99; CI) 0.98-1.00) and (OR 1.03; CI 1.01-1.05), respectively. However, it isn't significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors and vomiting and stomach symptoms.

Neuro symptoms

Results indicated that operators who exposed to cypermathrin in air while spraying were 1 times more likely to drowsiness (OR1.02; CI 0.99-1.03) and 1 times who exposure to benzene and toluene more likely to dizziness (OR 0.98; CI 0.97-1.00) and (OR 1.12; CI 1.0-1.2), respectively. Interestingly, operators who did not used PPE regularly were 4.4 times (OR 4.39; CI 0.5-3.29) and 1.4 times for operators who don't use PPE more likely to dizziness and headaches, respectively. No significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors and confusion and anxiety.

Respiratory symptoms

Difficult breathing was greater among operators who reported that they could expose chemical by spraying for long time (odds ratio (OR), 4.01 95% confidence interval (CI) 1.4-11.0). In addition, operators who exposed to cypermathrin while spraying were 1 times more likely to difficult breathing (odds ratio (OR), 1.03; 95% confidence interval (CI) 1.0-1

Table 4.4 Factors association with prevalence of health symptoms during working ((odds ratio (OR) and 95% confidence interval (CI)

Table 4.4 Factors association with prevalence of health symptoms during working ((odds ratio (OR) and 95% confidence interval (CI))

Health symptoms	Factors													
	Chemicals exposure (Air concentration)			Metabolites (urine)			Personal and working condition							
	Cypermethrin	Benzene	Toluene	3 PBA	T muconic	O-cresol	Age	Education	Smoking	Drinking	Food	Time spraying	PPE use regularly	Indoor spraying
Facial burning	1.03* (1.00-1.05)					1.01* (1.00-1.01)		0.64 (0.20-1.70)					1.38 (0.60-3.60)	0.68* (0.10-3.20)
Paresthesia			1.02 (1.00-1.02)		0.95 (0.88-1.03)		1.05 (0.99-1.12)							0.16* (0.04-0.55)
Itchy	0.98 (0.94-1.03)	1.02* (1.00-1.03)		2.82* (1.30-5.06)		1.01 (0.99-1.02)		0.75 (0.20-2.76)			0.4 (0.10-1.77)	0.52 (0.14-1.90)		0.37 (0.05-2.89)
Running nose								0.53 (0.20-1.38)					1.78 (0.73-4.33)	
Sore throat				1.25 (0.98-1.58)	0.927 (0.84-1.02)		0.96 (0.92-1.01)			0.63 (0.14-2.86)			6.08* (1.61-22.97)	
Blurred vision		1.01* (1.00-1.03)				1.00 (0.99-1.01)	0.96 (0.92-1.01)							1.46* (0.53-4.67)
Rash									1.96 (0.60-6.45)		0.295 (0.01-1.28)	0.40 (0.14-1.18)		
Fatigue		1.00* (1.00-1.01)	1.008 (0.99-1.02)		0.92 (0.85-1.00)				0.27* (0.05-0.80)	3.70* (0.95-14.39)		0.43* (0.17-1.11)	0.30* (0.10-0.87)	
Muscle weakness									4.16 (0.76-22.76)	0.365 (0.76-1.76)				

Table 4.4 Factors association with prevalence of health symptoms during working ((odds ratio (OR) and 95% confidence interval (CI))

Health symptoms	Factors													
	Chemicals exposure (Air concentration)			Metabolites (urine)			Personal and working condition							
	[illegible]	Benzene	Toluene	3 PBA	T [illegible]	O-cresol	Age	Education	Smoking	Drinking	Food	Time spraying	PPE use regularly	Indoor spraying
Dizziness		**0.98*** (0.97-0.99)	**1.12**** (1.00-1.20)				0.93 (0.80-1.00)		**0.73** (0.10-5.10)					4.39 (0.50-32.90)
Headaches		0.99 (0.98-1.00)	**1.06*** (1.04-1.09)		0.92 (0.82-1.02)				0.66 (0.14-3.11)	0.36 (0.05-2.51)		**0.21*** (0.05-0.92)		2.82 (0.60-13.15)
Confusion	none													
Anxiety	none													
Nausea		**0.99*** (0.98-1.00)	**1.04*** (1.02-1.05)		0.92 (0.85-1.02)	1.01 (1.00-1.012)			0.77 (0.20-2.89)	0.34 (0.05-1.95)				0.58 (0.42-5.84)
Vomiting	none													
Stomachache	none													
Wheezing											5.83 (0.83-41.01)		4.64 (0.66-32.74)	
Cough				1.03 (0.97-1.10)									4.58 (0.60-30.60)	
Difficult Breathing	**1.03*** (1.00-1.06)			0.72 (0.48-1.08)	1.03 (0.97-1.10)							**4.04*** (1.47-11.07)		1.21 (0.24-6.06)

***P value* ≤0.5**

4.3.2 Occupational risk factors associate with health workers symptoms after spraying 24 hours

Table 4.5 shows the results from final multiple logistic regression after spraying 24 hours

Eye and facial irritation symptoms

Results indicated that time spraying were 0.3 times more likely to facial burning (odds ratio (OR), 0.30; 95% confidence interval (CI) 0.1-0.8). Moreover, operators who worked long time spraying were odds ratio of itchy/scratchy or eye irritation was approximately 0.4 times (OR 0.39: CI 0.15-0.98).

Skin symptoms

No significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors and skin symptoms or rash.

Muscular symptoms

Results indicated that VCOs who exposed with toluene in air while spraying were 1 times (OR 1.0; CI 1.-1.02) and found tt-muconic in urine were 1 time (OR 0.93; CI 0.3.-0.99) more likely to fatigue ,respectively.

Digestion symptoms

No significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors with nausea, vomiting, stomachache and skin symptoms or rash

Neuro symptoms

No significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors with headaches, dizziness, drowsiness, confusion and anxiety.

Respiratory symptoms No significant associations were found between operators exposed to chemicals, biological monitoring, personal and working condition factors with cough, wheezing and difficult breathing

Table 4. 5 Factors association with prevalence of health symptoms after spraying 24 hours ((odds ratio (OR) and 95% confidence interval (CI)

Table 4.5 Factors association with prevalence of health symptoms after spraying 24 hours ((odds ratio (OR) and 95% confidence interval (CI))

Health symptoms	Factors														
	Chemicals exposure (Air concentration)			Metabolites (urine)		Personal and working condition									
	Cypermuathrin	Benzene	Toluene	3 PBA	T tmuconic	O-cresol	Age	Education	Smoking	Drinking	Food	Time spraying	PPE use regularly	Indoor spraying
Facial burning				0.96 (0.8-1.0)					0.50 (0.1-1.4)			0.30. (0.1-0.8)		0.38 (0.1-1.0)
Paresthesia	0.97 (0.9-1.0)	0.99 (0.9-1.0)	1.0 (0.9-1.02	1.47 (0.9-2.3)		1.0 (1.0-1.02)							2.96 (0.9-9.2)	
Itchy			1.0 (0.9-1.01)		0.93 (0.8-98)							0.39. (0.15-0.98)	1.97 (0.7-5.2	
Running nose								none						
Sore throat								none						
Blurred vision		1.0 (0.9-1.01)				1.0 (0.9-1.01)	0.96 (092-1.01)	1.01 (0.9-1.06)					1.21 (0.4-3.2)	0.60 (0.2-1.7)
Rash									196 (0.60-645)		0.295 (0.01-1.28)	0.40 (0.14-1.18)		
Fatigue		1.01. (1.0-1.02)		0.93. (0.8-0.99)			1.02 (0.9-1.06)							
Muscle weakness														

Drowsiness, dizziness, Headaches, Confusion, Anxiety, Nausea, Vomiting, Stomachache, Wheezing, Cough, Difficult Breathing prevalence was no association with chemical exposure, metaboline and personal working conditions at after working

4.3.3 Occupational risk factors associate with health workers symptoms none working

Health workers symptoms prevalence was very few, so researcher did not measure this section.

4.4 Effectiveness of a Safety chemical program

This section shows effectiveness of a safety chemical program base on evaluation in three components which consists of improvement in pesticide use safety behaviors, reduction in the operators' spraying-related chemical exposure (metabolite), improvement in the operators' health situation and lung function test.

4.4.1 Effectiveness of improvement chemical safety behavior

4.4.1.1 Overall effectiveness of intervention on improvement chemical safety behavior score

Effectiveness of safety chemical program on improvement chemical safety behavior was measured safety score by interviewed with questionnaire (Appendix A) and observed working conditions after operators working in control group and intervention group at baseline and follow up 1. General Linear Model repeated-measures was used to assess overall effectiveness of safety chemical program on improvement chemical safety behavior

After intervention, means safety score in the intervention group had rapidly increased in Follow-up1 (64.77) and slightly decreased in Follow-up2 (64.75), In contrast, the control group's measurements had slightly increased in Follow-up1(53.19) and decreased in Follow-up2(52.0). For intervention effects, safety score in the intervention group were increased significantly than control group by both Follow-up1(12.58) and Follow-up2(13.75) with $p < 0.001$, shown in Table 4.6 and Figure 4.7

Table 4.6 ***Overall effectiveness of safety chemical program on improvement chemical safety score at baseline, follow-up 1 and follow-up2***

Parameter	F	Hypothesis df	Error df	*p-value*
Safety score	1.425	2	93	<0.001

General Linear Model repeated-measures analysis of variance (Wilks' Lambda test from Multivariate test)

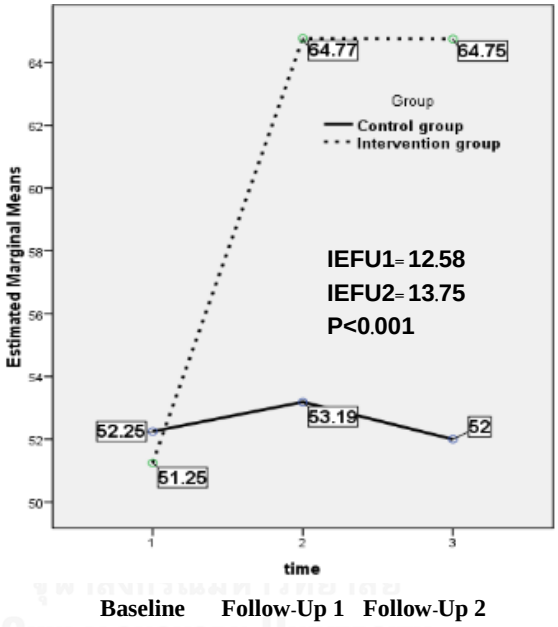


Figure 4.1 ***Means of safety score in intervention group and control group at Baseline, Follow-up 1, and Follow-up 2(GLM)***

4.4.1.2 Intervention effects of chemical safety score with model for time and group interaction

General linear mixed model to analyze effectiveness of safety chemical program on improvement chemical safety score for the effect of time and intervention at baseline, follow-up2 and follow-up1. Results found chemical safety score were significant difference at both follow-up 1(*p-value* <0.001) and follow-up 2((*p-value* <0.001), shown Table 4.7.

Table 4.7 ***Absolute magnitudes of intervention effects in chemical safety score compare to baseline prevalence***

Parameter	Intervention effects			
	Follow-up 1		Follow-up 2	
	Magnitude (95%CI)	*p-value*	Magnitude (95%CI)	*p-value*
Safety score	+12.58 (11.10,14.05)	<0.001	+13.75 (12.04,15.45)	<0.001

Generalized mix model estimating equations with times and time interaction, (Distrition=Poisson, Link = Identity)

IEFU1 = difference of mean of safety score in intervention group (baseline - follow up1) minus difference of mean safety score in control group (baseline -follow up1)

IEFU2 = difference of mean of safety score in intervention group (baseline - follow up2) minus difference of mean safety score in control group (baseline -follow up2)

4.4.2 Effectiveness of a safety chemical program on reducing the operators' spraying-related chemical (metabolite) exposure.

4.3.2.1 Overall effectiveness of safety chemical program on reducing chemical (metabolite) exposure among intervention and control groups at Baseline, Follow-Up 1, and Follow-Up 2.

Urine samples were taken from operators six hours and 12 hours after shift work that included benzene and toluene spraying. The urine samples were tested for 3-PBA (as cypermethrin metabolite); results at Baseline, Follow-Up 1, and Follow-Up 2 are given in Figure 4.2. These results show that the average metabolite concentration (ug/g creatinine) in the intervention group (4.76) was lower than the control group (5.26) at Baseline. In Follow-Up 1 (one month after intervention), after the intervention group received a safety chemical program (intervention), means of 3-PBA concentration had decreased to 1.33 in the intervention group, while the control group increased slightly

(to 6.60). In Follow-Up 2, average metabolite declined again in the intervention group (to 1.08) and decreased for the first time in the control group (to 5.56). The magnitudes of Intervention (IE) from Baseline to Follow-Up 1 (IEFU1) and from Baseline to Follow-Up 2 (IEFU2) were -3.98 and -4.76, respectively.

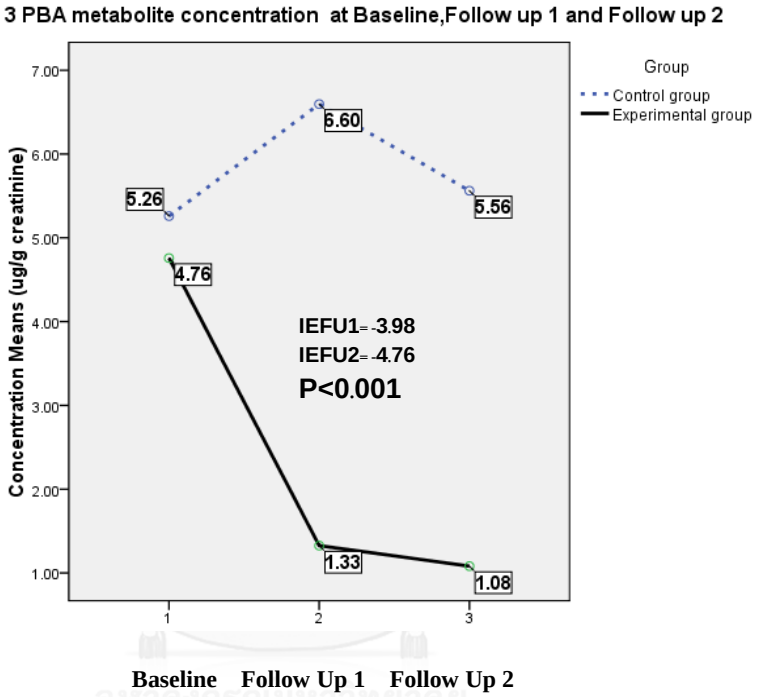


Figure 4.2 ***Means*** *of 3-PBA in intervention group and control group at Baseline, Follow Up 1, and Follow Up 2.(GLM test)*

The urine measurements for tt-MA (as benzene metabolite) at Baseline, Follow-Up 1, and Follow-Up 2 are shown in Figure 4.3. These results show that the average metabolite concentration in the intervention group (14.75) was lower than the control group (16.76) at Baseline. In Follow-Up 1, after operators in the intervention group received a safety chemical program (intervention), means of tt-MA concentration had significantly decreased to 6.85 in the intervention group, while the control group

decreased only slightly to 14.47. However, in Follow-Up 2, average metabolite increased moderately in the intervention group (to 9.21) but increased greatly in the control group (to 27.31). The magnitudes of Intervention (IE) from Baseline to Follow-Up 1 (IEFU1) and from Baseline to Follow-Up 2 (IEFU2) were -5.59 and -16.08, respectively.

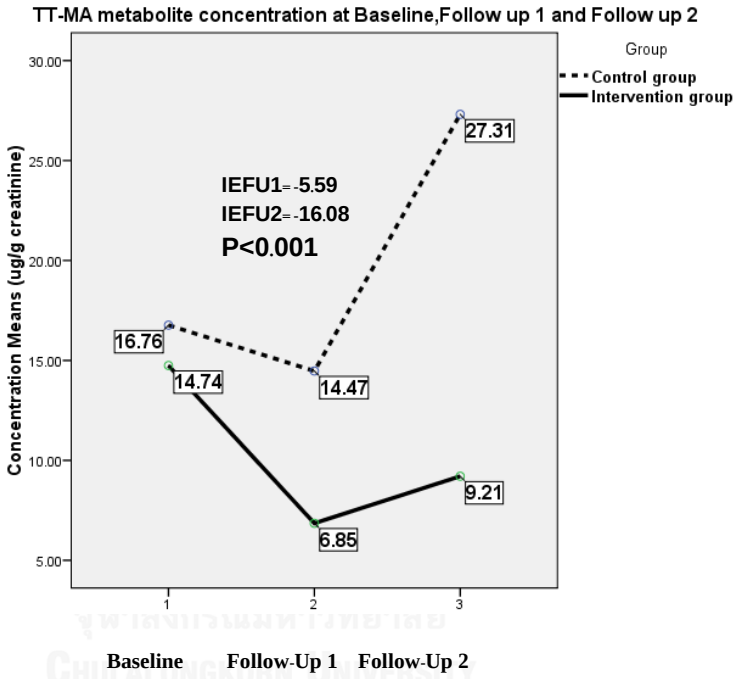


Figure 4.3 ***Means of tt-MA in intervention group and control group at Baseline, Follow Up 1, and Follow Up 2 (GLM test)***

The urine measurements of o-cresol (as toluene metabolite) at Baseline, Follow-Up 1, and Follow-Up 2 are shown in Figure 4.4. After intervention, the intervention group metabolite measurements (37.42) were decreased significantly by Follow-up 1 than in the control group (172.67) and slightly increase at Follow-up 2 (70.18). In contrast, the control group's measurements had increased at both Follow-Up 1 and Follow-Up 2, clearly indicating that intervention methods were successful. The

magnitude of Intervention (IE) from Baseline to Follow-Up 1 (IEFU1) and from Baseline to Follow-Up 2 (IEFU2) was -127.66 and -122.72, respectively.

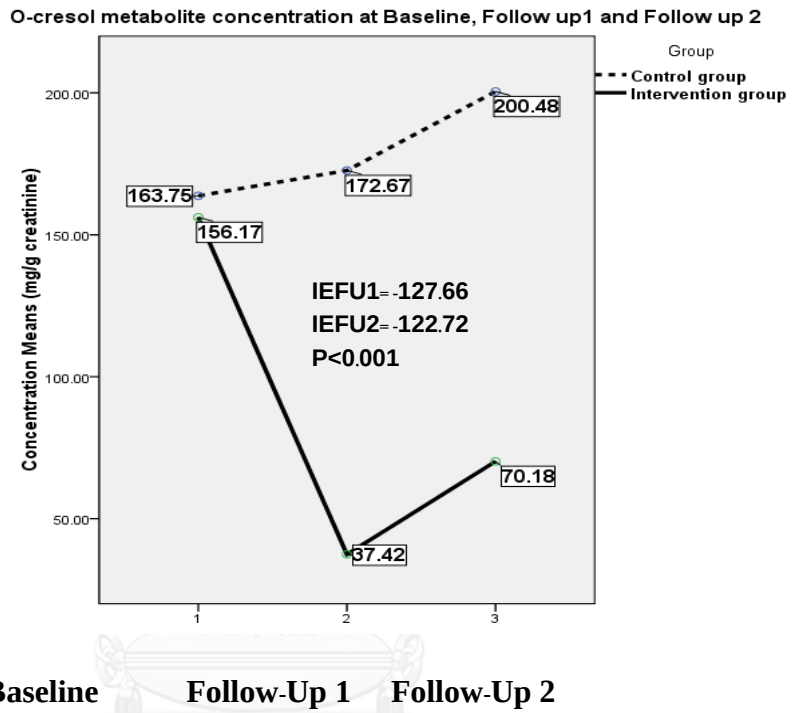


Figure 4. 4 Means of o-Cresol in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM test)

The overall effectiveness of the intervention on reducing chemical (metabolite) exposure was assessed using the General Linear Model of repeated-measure ANOVA. There was a statistically significant effect in chemical exposure at p< 0.001 (Wilks', Lambda from multivariate test). The findings revealed the interaction of the groups and time on metabolite concentration between intervention and control groups for 3-PBA (F=1.84, p<0.001), tt-MA (F=0.705, p<0.001) and o-Cresol (F=0.651, p<0.001). There were

statistically highly significant differences between mean metabolite concentration of 3-PBA, tt-MA and o-Cresol by group and time of measurement as presented in Table 4.8.

Table 4.8 ***Overall effectiveness (intervention effects (IE)) of a safety chemical program on reducing chemical (metabolite) exposure among intervention and control groups at Baseline to Follow-Up 1 (IEFU1) and Baseline to Follow-Up 2(IEFU2).***

	IEFU1	**IEFU2**	**F**	**Hypothesis df**	**Error df**	***p*-value**
3-PBA	-3.98	-4.76	1.840	2.000	93	<0.001
tt-MA	-5.59	-16.08	0.705	2.000	93	<0.001
O-Cresol	-127.66	-122.72	0.651	2.000	93	0<.001

General Linear Model repeated-measure ANOVA (Wilks' Lambda from multivariate test)

Note.

IEFU1 = Difference of mean metabolite concentration in intervention group (Baseline – Follow-Up 1) minus difference mean metabolite concentration in control group (Baseline - Follow-Up 1)

IEFU2 = Difference of mean metabolite concentration in intervention group (Baseline – Follow-Up 2) minus difference mean metabolite concentration in control group (Baseline - Follow-Up 2)

4.4.2.2 Intervention effects of a safety chemical program on reducing chemical (metabolite) exposure, adjusted for time and time-group interaction (continuous).

The intervention effects of continuous dependent variables (3-PBA, tt-MA and o-Cresol) were adjusted for time and time-group interaction using mixed models. Intervention effected the levels of all metabolites (3PBA,tt-MA and o-Cresol) was significantly decreased their presence as measured between Baseline and Follow-Up 1

and again between Follow-Up 1 and Follow-Up 2 with (p value < 0.001). See in Table 4.9

Table 4. ***9 Intervention effects of safety chemical program on reduces chemical metabolite adjusted for time and time group interaction (continuous)***

Chemical Metabolite	Intervention effects			
	Follow-Up 1		Follow-Up 2	
	Magnitude 95% CI	P value	Magnitude 95% CI	P value
3-PBA	-4.76 (-5.64, -3.89)	<0.001	-3.97 (-5.08, -2.87)	<0.001
TT-MA	-5.59 (-8.57, -2.61)	<0.001	-16.08 (-21.19, -10.97)	<0.001
O-Cresol	-127.66 (-164.66, -90.66)	<0.001	-122.72 (-159.21, -86.23)	<0.001

Note. Generalized estimating equations with times and time interaction (Distrition=Poisson, Link = Identity)

4.4.3 Effectiveness of improvement in the operators' health situation during working.

4.4.3.1 Overall effectiveness of intervention on improving the operators' health.

The vector control operators' (VCOs) health was categorized by organ system, including skin, muscular, neurological, digestive, and respiratory. General Linear Model repeated-measure ANOVA was used to test intervention effects. For skin systems, results indicated that intervention effected facial burning, paresthesia, blurred vision and itchy/eye irritation in a similar pattern. Overall, there was a significant decreased in the occurrence of all symptoms in the intervention group between Baseline and Follow-

Up 1, and this reduction was either sustained or further reduced between Follow-Up 1 and Follow-Up 2. In contrast, the control group's symptoms increased bewteen Baseline and Follow-Up 2 for all system types except eye irritation, which decreased a marginal amount. First, the results show the mean number of facial burning in the intervention group (0.604) was lower than in the control group (0.625) at Baseline. After the intervention program, at Follow-Up 1, mean number of facial burning in the intervention group had greatly decreased to 0.188. The control group, in contrast increased slightly to 0.646. Likewise, at Follow-Up 2, the mean number of facial burning in the intervention group was unchanged from Follow-Up 1 (0.188), while the control group had increased slightly again to 0.72, as shown in Figure 4.5(a). Second, the mean number paresthesia in the intervention group (0.208) was lower than in the control group (0.271) at Baseline. At Follow-Up 1, the mean number of paresthesia in the intervention group had decreased to 0.167, while the control group increased to 0.396. Similarly, the mean number of paresthesia in the invention group at Follow-Up 2 decreased again to 0.104, but greatly increased to 0.542 in the control group, as seen in Figure 4.5(b). Third, the average incidence of blurred vision in the intervention group (0.667) was higher than the control group (0.458) at Baseline. At Follow-Up 1, the mean number of blurred vision symptoms in the intervention group had sharply decreased to 0.146, followed by no change at Follow-Up 2. The control group increased slightly to 0.604 at Follow-Up 1 and decreased slightly at Follow-Up 2 (0.542), as seen in Figure 4.5(c). Fourth, the mean

number of itchy eyes and other eye irritation was lower in the intervention group (0.542) than in the control group (0.771) at Baseline. The mean number of itchy eyes and other eye irritation in the intervention group decreased sharply to 0.208 at Follow-Up 1 and again to 0.125 at Follow-Up 2. These results remained lower than the control group at both Follow-Up 1 (0.750) and Follow-Up 2 (0.667), which saw a slight decrease from Baseline. See Figure 4.5(d).

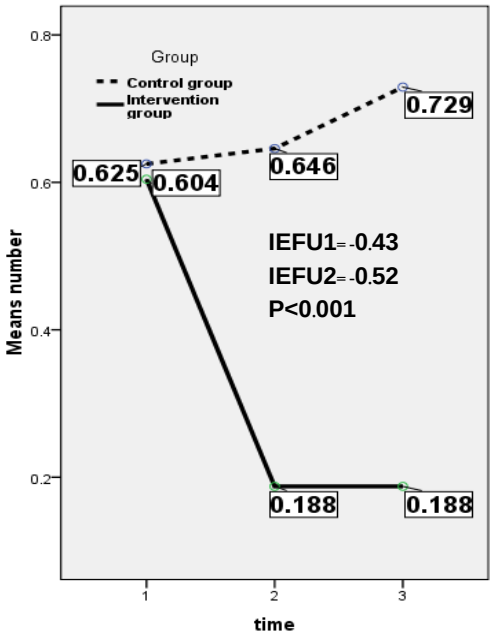


***Figure 4.5a** Means of facial burning (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)*

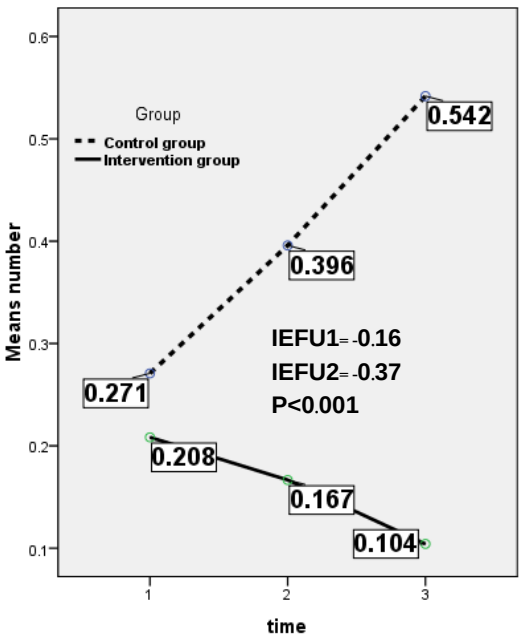


***Figure 4.5 b** Means of paresthesia (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)*

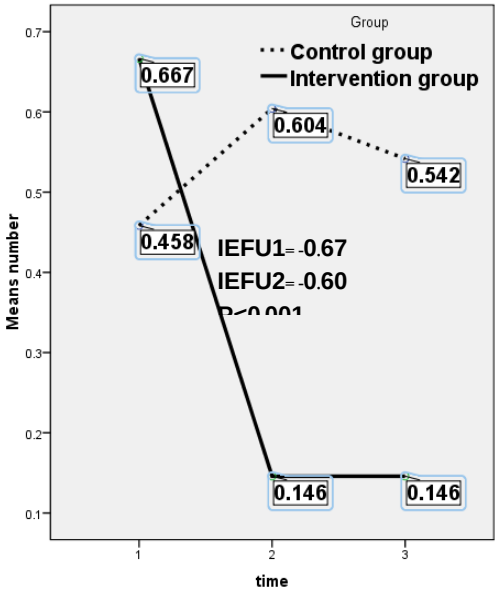


***Figure 4.5c** Means of blurred vision (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)*

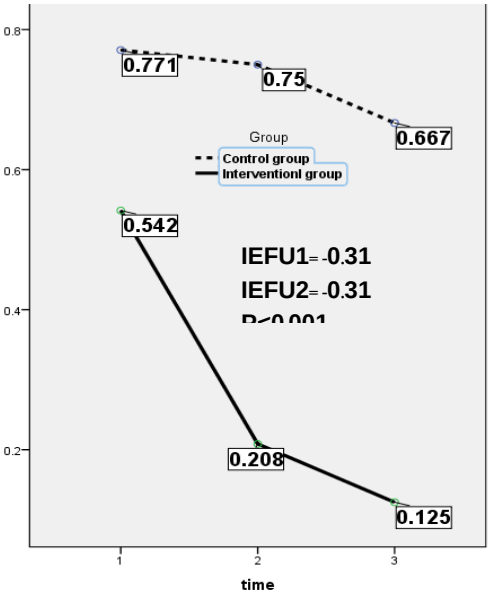


***Figure 4.5 d** Means of itchy, scratchy eye (working) in intervention group and control groupat Baseline, Follow-Up 1 and , Follow-Up 2 (GLM)*

Finally, the average number of rash/itchy skin reactions in the intervention group (0.229) was higher than in the control group (0.146) at Baseline. At Follow-Up 1 and Follow-Up 2, this number greatly decreased to 0.062 and 0.042, respectively, in the intervention group, remaining lower than in control group at the same time periods (0.312 and 0.333). See Figure 4.5(e).

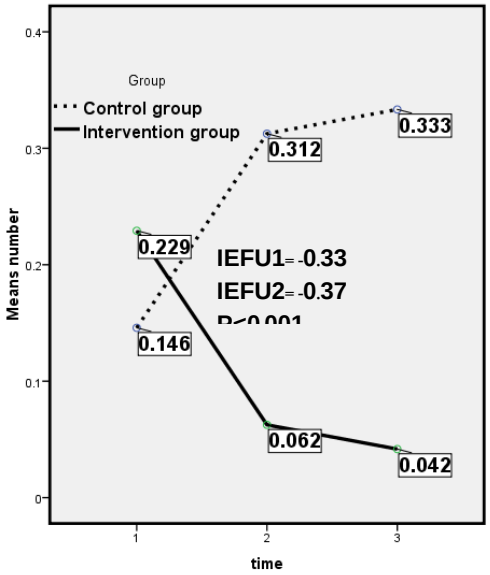


Figure 4.5 a Means of rash/itchy skin (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM test)

Next, the muscle system symptoms were examined. Overall, the intervention group showed less fatigue and muscle weakness after receiving the training program, while the control group continued to see increased symptoms at the same time of measure. Results, shown the mean number of fatigue incidence in the intervention group (0.601) was higher than in the control group (0.333) at Baseline. At Follow-Up 1, average incidences of fatigue in the intervention group decreased to 0.083, which was lower than control group, whose incidences greatly increased to 0.458. At Follow-Up 2, the mean number of fatigue increased in both groups, though the intervention group remained greatly decreased compared to Baseline and much lower than the control group. See Figure 4.6(a). The average muscle weakness in the intervention group (0.083) was lower than in the control group (0.16) at Baseline. At Follow-Up 1, the mean number of muscle

weakness in the intervention group greatly decreased to 5.2E-18, but increased slightly in the control to 0.188E-1. By Follow-Up 2, the intervention group's mean number of muscle weakness again decreased slightly to 1.73E-18, while the control group had greatly increased to 2.29E-1. See Figure 4.6(b).

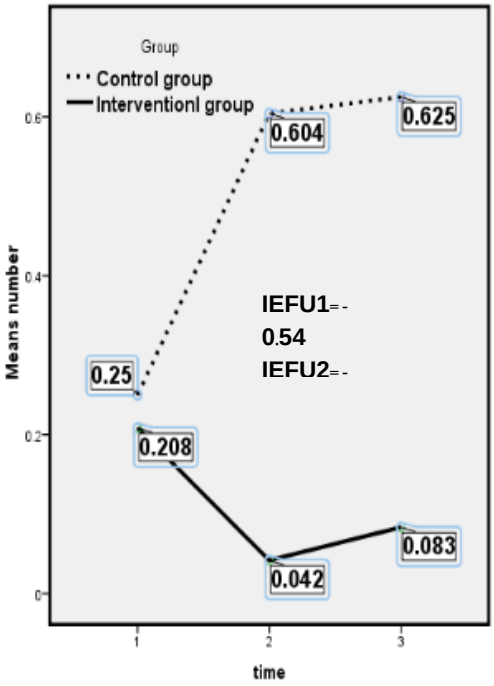


Figure 4.6 a ***Means of fatigue (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)***

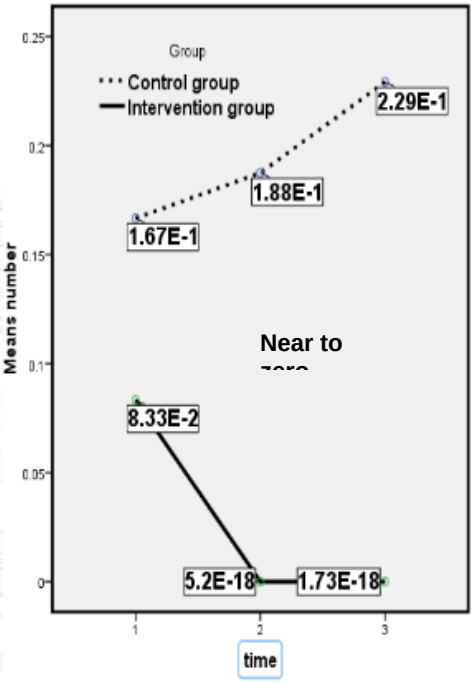
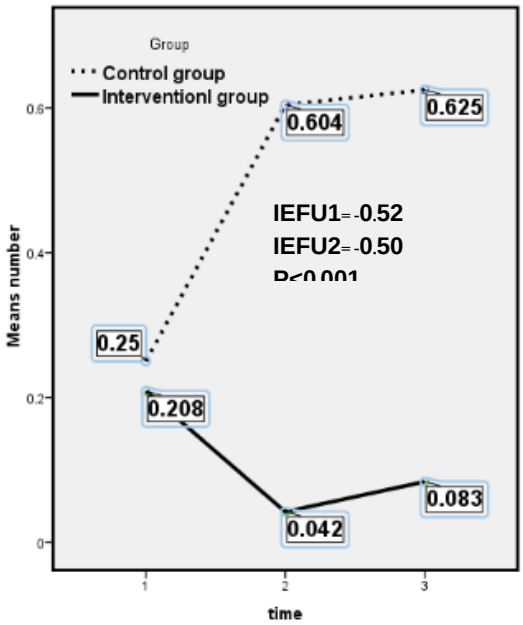


Figure 4.6 **b** ***Means of muscle weakness (working) in intervention group and control groupat Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)***

Neurological system symptoms that were studied included drowsiness, dizziness, and headaches. First, the average incidence of drowsiness in the intervention group (0.208) was lower than in the control group (0.26) at Baseline. At Follow-Up 1, the mean number of drowsiness in the intervention group decreased to 0.042, lower than control group, which increased greatly to 0.604. At Follow-Up 2, the mean number of drowsiness in the intervention group increased slightly to 0.083, yet remained lower than the control group, which saw another increased. See Figure 4.7(a). Second, the mean number of dizziness reported in the intervention group (6.46E-1) was lower than in the control group (7.92E-1) at Baseline. At Follow-Up 1, average rate of dizziness in both the intervention and control groups decreased greatly, to 2.08E-2 and 5.62E-1, respectively. In Follow-Up 2, intervention and control group mean numbers decreased slightly (3.3E-17 and 5.21E-1, respectively). This is presented in Figure 4.7(b). Third, at Baseline, the average rate of headaches in the intervention group(0.625) were equal to the mean number of headaches in the control group (0.625). At Follow-Up 1, intervention group headaches decreased significantly to 0.042, much lower than control group (0.458), although they also saw a reduction in headache incidences. At Follow-Up 2, the control group slightly increased headache incidence to 0.521, while the intervention group remained unchanged (0.042). See Figure 4.7(c). Fourth, the mean number of confusion did not change for either group at any point in our study, as seen in Figure 4.7(d). Finally, the average report of anxiety in the intervention group was equal to that of the control group at Baseline. At Follow-Up 1, the mean number of anxiety in the

control group went unchanged, but dropped to 0.02 at Follow-Up 2. However, the anxiety reports dropped to 0 and stable by Follow-Up 1 and remained stable through Follow-Up 2. See Figure 4.7(e).



Baseline Follow-Up 1 Follow-Up 2

Figure 4.7 *a Means of drowsiness (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM test)*

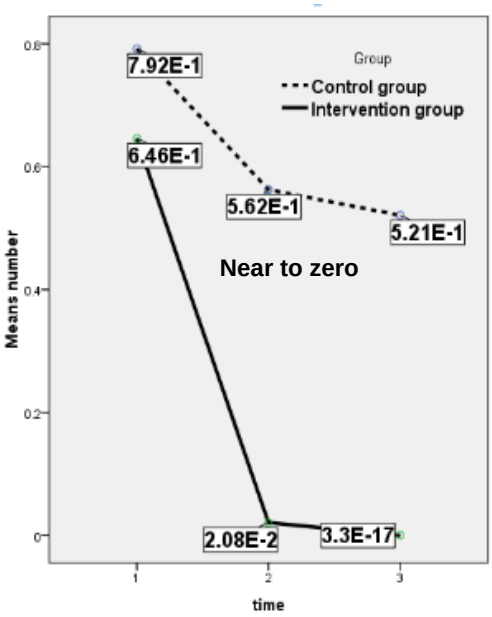


Figure 4.7 b *Means of dizziness (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM)*

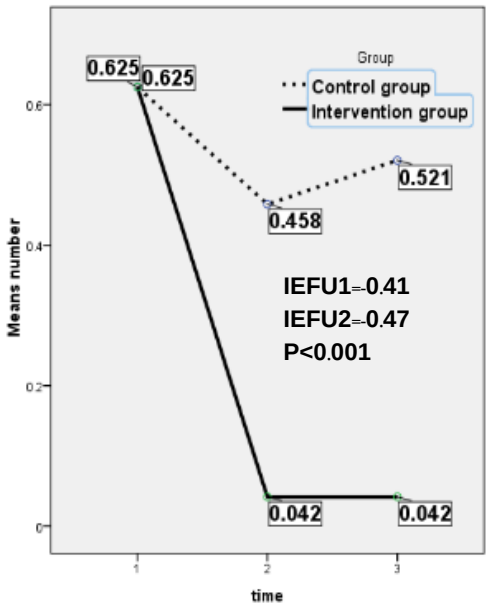


Figure 4.7 c *Means of headaches (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2*

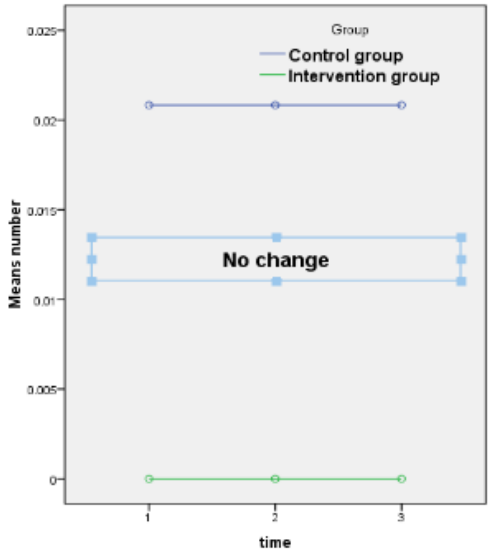


Figure 4.7 d *Means of confusion (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)*

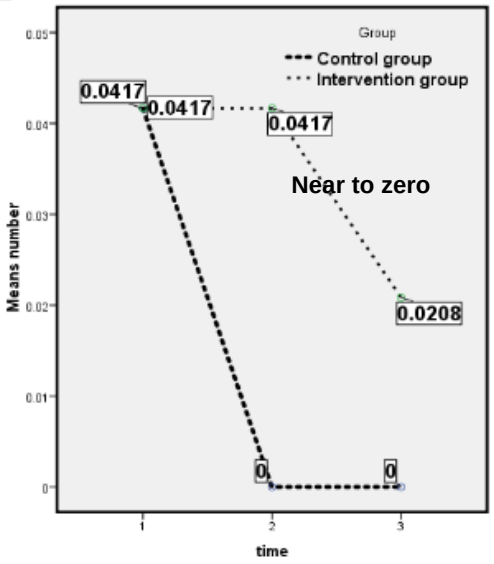


Figure 4.7 e *Means of anxiety (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)*

For digestive systems, mean number of vomiting and stomachaches were unchanged in both the intervention group and control group at Baseline, Follow-Up 1, and Follow-Up 2, as seen in Figures 4.8(a) and 4.8(b). However, the mean number of nausea in the intervention group (0.479) was lower than in the control group (0.625) at Baseline. At Follow-Up 1, there was no change in mean nausea for either group, but by Follow-Up 2, the mean number of nausea in the intervention group decreased slightly 0.417 while the control group decreased greatly to 0.5. This is shown in Figure 4.8(c).

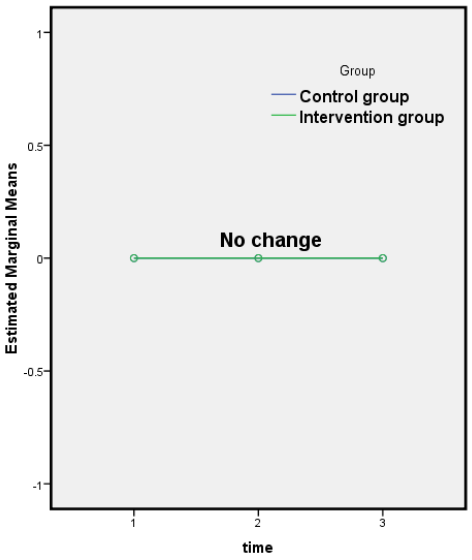


Figure 4.8 a ***Means of vomiting (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)***

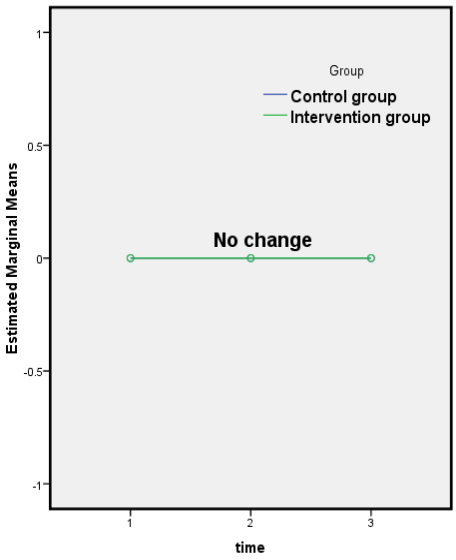
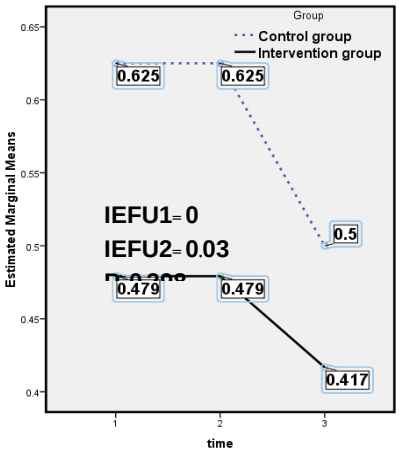


Figure 4.8 b ***Means of stomachaches (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2***

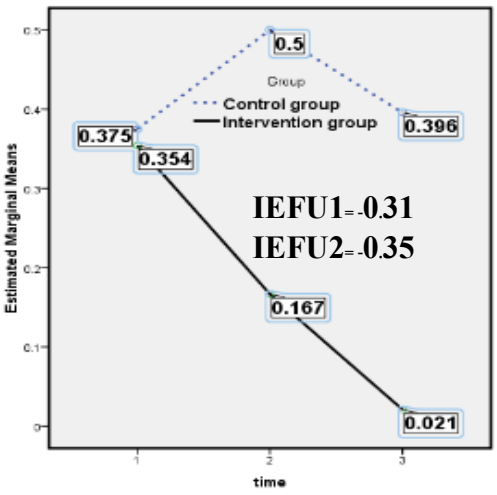


Baseline **Follow-Up 1** **Follow-Up 2**

Figure 4.8 c Means of nausea (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)

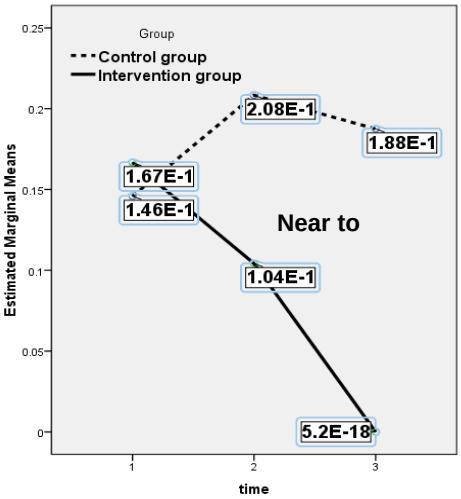
For respiratory systems, average numbers of runny nose, sore throat, cough, wheezing, and difficult breathing were taken for each group. First, the mean number of runny noses in the intervention group (0.354) was lower than in the control group (0.375) at Baseline. The mean number of runny noses in the intervention group decreased in both Follow-Up 1 and Follow-Up 2, to 0.167 and 0.02, respectively. The control group average increased in Follow-Up 1 (0.5), then decreased in Follow-Up 2 (0.396), remaining slightly higher than Baseline. See Figure 4.9(a). Second, the mean number of sore throats in the intervention group (1.46E-1) was lower than in the control group (1.67E-1) at Baseline. At Follow-Up 1, the mean number of sore throats in the intervention group decreased to 1.04xE-1, whereas the mean number of sore throats in the control group slightly increased to 2.08E-1. At Follow-Up 2, the mean number of sore throats in the intervention group had decreased greatly to (5.2E-18) while the control group decreased slightly to 1.88E-1, as seen in Figure 4.9(b). Third, the mean number of

cough reported in intervention group (0.042) was lower than in the control group (0.104) at Baseline. At Follow-Up 1, the mean number of cough remained unchanged in both groups. However, in Follow-Up 2, the mean number of cough increased slightly in the intervention group (0.083) and greatly in the control group 0.292, as seen in Figure 4.9(c). Fourth, at Baseline, the mean number of wheezing in the intervention group (0.021) was lower than in the control group (0.083), and both groups remained unchanged at Follow-Up 1. At Follow-Up 2, the mean number of wheezing slightly increased in the intervention group (0.042), but greatly increased in the control group (0.271), as seen in Figure 4.9(d). Finally, the average number of difficult breathing reported by the intervention group and the control group were stable across at Baseline and Follow-Up 1, though the intervention group was lower. At Follow-Up 2, the mean number of difficult breathing greatly decreased in the intervention group to 0.188, while the control group remained unchanged. See Figure 4.9(e).



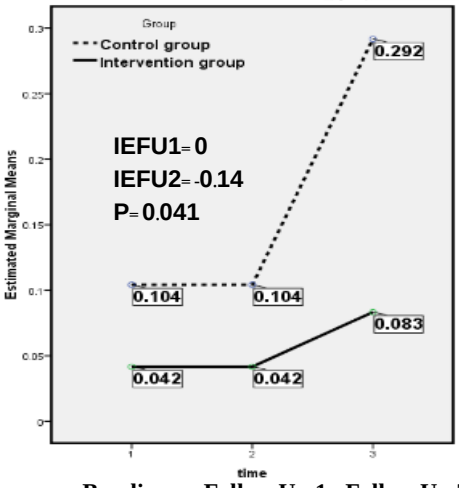
Baseline Follow-Up 1 Follow-Up 2

Figure 4.9 a Means of runny noses (working) in intervention group and control group at Baseline, Follow-Up 1



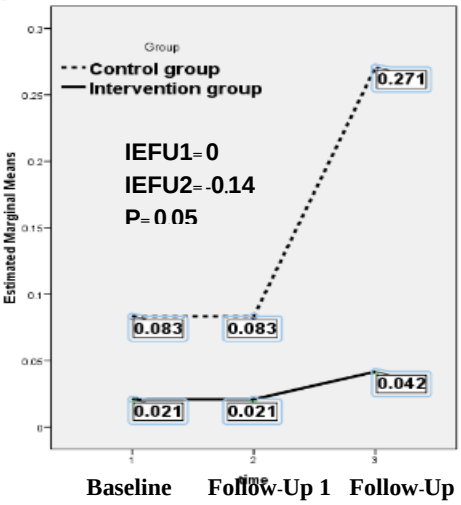
Baseline Follow-Up 1 Follow-Up 2

Figure 4.9 b Means of sore throats (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2



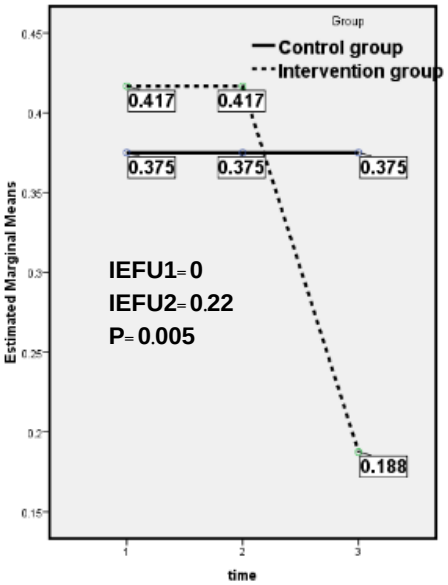
Baseline Follow-Up 1 Follow-Up 2

Figure 4.9 c Means of cough (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)



Baseline Follow-Up 1 Follow-Up 2

Figure 4.9 d Means of wheezing (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM test)



Baseline Follow-Up 1 Follow-Up 2

Figure 4.9 e Means of difficult breathing (working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM test)

The overall effectiveness of intervention program, there were statistically highly significant differences between mean numbers of health symptoms by organ system among VCOs. However, there were not statistically significant differences between mean numbers of anxiety, nausea, and sore throat. Mean numbers of confusion, vomiting, and stomachaches exhibited no change over time, as shown in Table 4.10

The intervention effects (IE) are expressed as magnitude of intervention effect (IEFU). IE from Baseline to Follow-Up 1 (IEFU1) is calculated as the difference of mean numbers of health symptoms in the intervention group (Follow-Up 1 – Baseline) minus the difference of mean numbers of health symptoms in the control group (Follow-Up 1 – Baseline). IEFU2 is calculated as the difference of mean numbers of health symptoms in the intervention group (Follow-Up 2 – Baseline) minus the difference of mean numbers of health symptoms in the control group (Follow-Up 2 – Baseline). For eye, facial, and skin systems, the intervention program improved VCO health, reducing facial burning, paresthesia, blurred vision, rash/itchy skin. For muscular systems, the intervention reduced fatigue symptoms. For neurological systems, drowsiness and headaches were reduced in the intervention group, Runny nose incidence was reduced in the intervention group. Cough, wheezing, and difficult breathing only effected the intervention group more than the control group at Follow-Up 2; IEFU2 was -0.14, -0.12, and -0.22, respectively, as shown in Table 4.10

Table 4. ***10 Overall effectiveness of safety chemical program on improvement in the operators' health situation during working among intervention and control groups at Baseline, Follow-Up 1 and Follow-Up 2.***

Health symptoms	IEFU1	IEFU2	F	Hypothesis df	Error df	*p*-value
Eye and facial						
Facial burning	-0.43	-0.52	10.55	2	93	<0.001
Paresthesias	-0.16	-0.37	17.52	2	93	<0.001
Blurred vision	-0.66	-0.60	19.19	2	93	<0.001
Itchy/scratchy eye	-0.31	-0.32	7.76	2	93	<0.001
Skin						
Rash/itchy skin	-0.33	-0.37	8.90	2	93	<0.001
Muscular						
Fatigue	-0.54	-0.56	13.51	2	93	<0.001
Muscle weakness	*	*	1.30	2	93	0.27
Neuro						
Drowsiness	-0.52	-0.56	11.84	2	93	<0.001
Dizziness	*	*	6.32	2	93	0.003
Headaches	-0.41	-0.47	8.60	2	93	<0.001
Confusion	No change	No change	*	*	*	*
Anxiety	*	*	1.50	2	93	0.22
Digestion						
Nausea	*	*	1.093	2	93	0.298
Vomiting	No change	No change	*	*	*	*
Stomach ache	No change	No change	*	*	*	*
Respiratory						
Runny nose	-0.31	-0.35	7.767	2	93	<0.001
Sore throat	*	*	3.083	2	93	0.051
Cough	*	-0.14	4.273	2	93	0.041
Wheezing	*	-0.14	6.089	2	93	0.05
Difficult breathing	*	0.22	8.183	2	93	0.005

Note. General Linear Model repeated-measure ANOVA (Wilks'' Lambda from multivariate test)

* Model did not run due to zero prevalence in one or more groups

IEFU1 = difference of mean of symptoms prevalence in intervention group (Baseline - Follow-Up 1) minus difference of mean in symptoms prevalence control group (Baseline -Follow-Up 1)

IEFU2 = difference of mean of symptoms prevalence in intervention group (Baseline - Follow-Up 2) minus difference of mean symptoms prevalence s in control group (Baseline -Follow-Up 2)

4.4.3.2 Intervention effects of dichotomous variables (health symptoms) during work with adjusted model for time and group interaction.

Generalized estimating equations with times and time interaction, Distrition=Poisson, Link = Identity, were used to test intervention effects of dichotomous variables (health symptoms) during work at Baseline, Follow-Up 1, and Follow-Up 2. For eye and facial symptoms of facial burning, paresthesia, blurred vision, and itchy/irritated eye, the intervention significantly reduced prevalence in both Follow-Up 1 and Follow-Up 2 with p value < 0.05. For skin symptoms of rash/itchy skin, muscle symptoms of fatigue, and neurological symptoms of headaches and nausea symptom, prevalence was also significantly reduced after intervention in both Follow-Up 1 and Follow-Up 2 with p value < 0.05. For the respiratory symptom of runny nose, prevalence was significantly reduced in both Follow-Up 1 and Follow-Up 2. Intervention effects were not present for sore throat, wheezing, cough, and difficult breathing at Follow-Up 1. Moreover, intervention effects of wheezing and cough symptoms increased at Follow-Up 2 when compared to the control group. However, the model did not run for the symptoms of muscle weakness**,** dizziness, **c**onfusion, anxiety, vomiting, and stomachache due to zero prevalence in one or more groups (as shown in Table 4.11.

Table 4. ***11 Absolute magnitudes of intervention effects in prevalence of health symptoms for during work compared to Baseline prevalence***

Health symptoms	Intervention effects			
	Follow-up 1		Follow-up 2	
	Magnitude (95%CI)	*p-value*	Magnitude (95%CI)	*p-value*
Eye and Facial				
Facial burning	-0.43 (-0.63,-0.23)	<0.001	-0.53 (0.11,-0.74)	<0.001
Paresthesia	-0.16 (-0.33,-0.003)	0.054	-0.37 (-0.56,-0.18)	<0.001
Blurred vision	-0.67 (-0.87,-0.45)	<0.001	-0.60 (-0.11,-0.82)	<0.001
Itchy/scratchy eye	-0.31 (-0.49,-0.13)	<0.001	-0.31 (-0.52,-0.09)	0.005
Skin				
Rash/itchy skin	-0.33 (-0.49,-0.17)	<0.001	-0.37 (-0.56,-0.18)	<0.001
Muscular				
Fatigue	-0.54 (-0.74,-0.33)	<0.001	-0.56 (-0.79,-0.18)	<0.001
Muscle weakness	*	*	*	*
Neurological				
Drowsiness	-0.52 (-0.72,-0.31)	<0.001	-0.50 (-0.73,-0.26)	<0.001
Headaches	-0.41 (-0.61,-0.21)	<0.001	-0.47 (-0.71,-0.24)	<0.001
Confusion	*	*	*	*
Anxiety	*	*	*	*
Digestive	*	*	*	*
Nausea	*	*	0.06 (0.059,-0.053)	0.29
Vomiting				
Stomachache	*	*	*	*
Respiratory				
Runny nose	-0.31 (-0.47,-0.14)	<0.001	-0.35 (-0.54,-0.16)	0.001
Sore throat	*	*	*	*
Cough	*	*	-0.14 (-0.28,-0.009)	0.037
Wheezing	*	*	-0.12 (-0.24,-0.003)	0.045
Difficult breathing	*	*	-0.22 (-0.38,-0.07)	0.004

Note. Generalized estimating equations with times and time interaction,(Distrition=Poisson, Link = Identity)

* Model did not run due to zero prevalence in one or more group

4.4.3.2 Intervention effects of dichotomous variables (health symptoms) during work with adjusted model for time and group interaction

. Generalized estimating equations with times and time interaction, Distrition=Poisson, Link = Identity, were used to test intervention effects of dichotomous variables (health symptoms) during work at Baseline, Follow-Up 1, and Follow-Up 2. For eye and facial symptoms of facial burning, paresthesia, blurred vision, and itchy/irritated eye, the intervention significantly reduced prevalence in both Follow-Up 1 and Follow-Up 2 with p value < 0.05. For skin symptoms of rash/itchy skin, muscle symptoms of fatigue, and neurological symptoms of headaches and nausea symptom, prevalence was also significantly reduced after intervention in both Follow-Up 1 and Follow-Up 2 with p value < 0.05. For the respiratory symptom of runny nose, prevalence was significantly reduced in both Follow-Up 1 and Follow-Up 2. Intervention effects were not present for sore throat, wheezing, cough, and difficult breathing at Follow-Up 1. Moreover, intervention effects of wheezing and cough symptoms increased at Follow-Up 2 when compared to the control group. However, the model did not run for the symptoms of muscle weakness**,** dizziness, **c**onfusion, anxiety, vomiting, and stomachache due to zero prevalence in one or more groups (as shown in Table 4.11.

Table 4. ***12 Absolute magnitudes of intervention effects in prevalence of health symptoms for during work compared to Baseline prevalence***

Health symptoms	Intervention effects			
	Follow-up 1		Follow-up 2	
	Magnitude (95%CI)	*p-value*	Magnitude (95%CI)	*p-value*
Eye and Facial				
Facial burning	-0.43 (-0.63,-0.23)	<0.001	-0.53 (0.11,-0.74)	<0.001
Paresthesia	-0.16 (-0.33,-0.003)	0.054	-0.37 (-0.56,-0.18)	<0.001
Blurred vision	-0.67 (-0.87,-0.45)	<0.001	-0.60 (-0.11,-0.82)	<0.001
Itchy/scratchy eye	-0.31 (-0.49,-0.13)	<0.001	-0.31 (-0.52,-0.09)	0.005
Skin				
Rash/itchy skin	-0.33 (-0.49,-0.17)	<0.001	-0.37 (-0.56,-0.18)	<0.001
Muscular				
Fatigue	-0.54 (-0.74,-0.33)	<0.001	-0.56 (-0.79,-0.18)	<0.001
Muscle weakness	*	*	*	*
Neurological				
Drowsiness	-0.52 (-0.72,-0.31)	<0.001	-0.50 (-0.73,-0.26)	<0.001
Headaches	-0.41 (-0.61,-0.21)	<0.001	-0.47 (-0.71,-0.24)	<0.001
Confusion	*	*	*	*
Anxiety	*	*	*	*
Digestive	*	*	*	*
Nausea	*	*	0.06 (0.059,-0.053)	0.29
Vomiting				
Stomachache	*	*	*	*
Respiratory				
Runny nose	-0.31 (-0.47,-0.14)	<0.001	-0.35 (-0.54,-0.16)	0.001
Sore throat	*	*	*	*
Cough	*	*	-0.14 (-0.28,-0.009)	0.037
Wheezing	*	*	-0.12 (-0.24,-0.003)	0.045
Difficult breathing	*	*	-0.22 (-0.38,-0.07)	0.004

Note. Generalized estimating equations with times and time interaction,(Distrition=Poisson, Link = Identity)

* Model did not run due to zero prevalence in one or more group

4.4.4 Effectiveness of improving the operators' health after working.

4.4.4.1 Overall effectiveness of intervention on improving the operators' health.

All skin system symptoms were significantly decreased in the intervention group at both Follow-Up 1 and Follow-Up 2. The control group saw increase in all symptom incidences over Baseline, except itchy/irritated eyes, which increased at Follow-Up 1 and decreased to below Baseline levels at Follow-Up 2. This difference was not statistically significant. See Figures 4.10(a)-4.10 (d). Results shown the mean number of facial burning reported after working was lower in intervention group (0.229) than control group (0.250) at Baseline. At Follow-Up 1, the mean number of facial burning in the intervention group had decreased (0.125), and was lower than that in the control group, which increased greatly to 0.312. At Follow-Up 2, the average number of facial burning in the intervention group went unchanged, while the control group reports slightly decreased, as presented in Figure 4.10(a). The average reports of paresthesia in the intervention group (0.188) was lower than in the control group (0.229) at Baseline. The mean paresthesia reported in the intervention group decreased greatly to 0.104 at Follow-Up 1 and 0.063 at Follow-Up 2, and remained lower than the control group, which steadily increased (0.275 and 0.292, respectively). See Figure 4.10(b). Average reports of blurred vision in the intervention group (0.312) were higher than in the control group (0.229) at Baseline. The mean number of blurred vision in the intervention group greatly decreased to 0.104 at Follow-Up 1 and 0.063 at Follow-Up 2, dropping lower than control group, which had saw a significant steady increase in

occurrence at both measurements (0.345 and0.458, respectively). See Figure 4.10(c). Mean number of itchy eyes and eye irritation in the intervention group (0.333) was higher than in the control group (0.229) at Baseline. The average number of itchy eyes and eye irritation in the intervention group greatly decreased to 0.083 at Follow-Up 1 and 0.062 at Follow-Up 2, dropping lower than control group, which decreased slightly (0.292 and 0.271, respectively). See Figure 4.10(d).

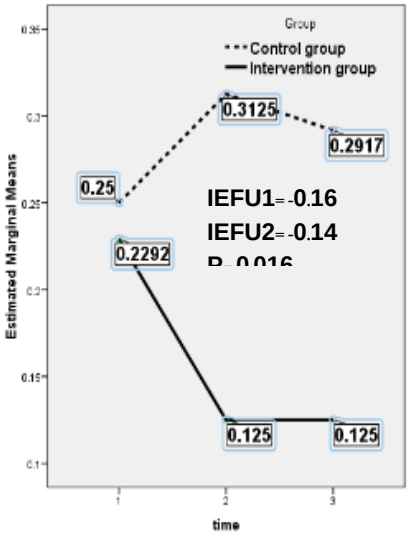


Figure 4.10 a Means of facial burning (after working) in intervention group and control groupat Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

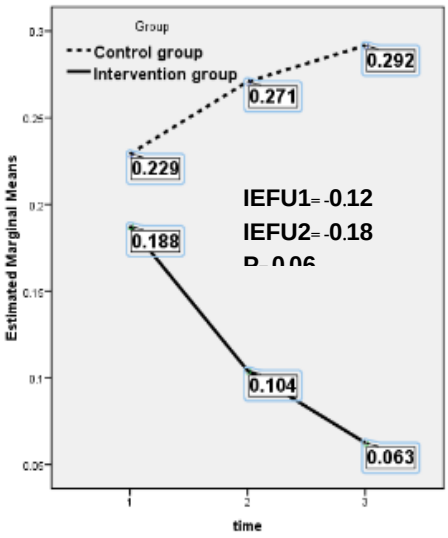


Figure 4.10 bMeans of paresthesia (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

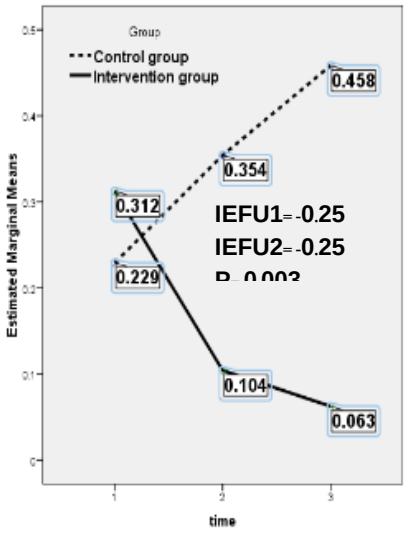


Figure 4.10 c Means of itchy (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

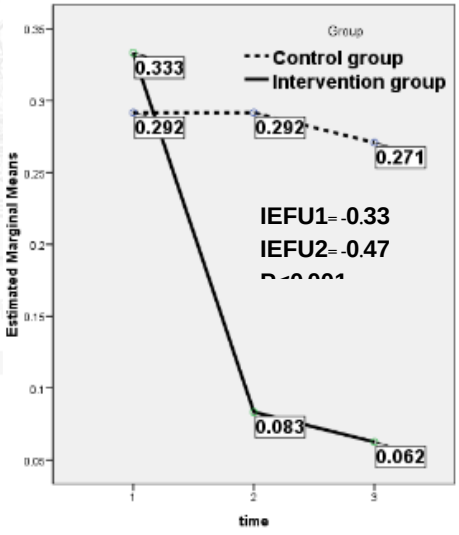


Figure 4.10 d Means of blurred vision (after working) in intervention group and control groupat Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

muscular system symptoms were also measured. First, the mean number of fatigue in the intervention group (0.438) was higher than in the control group (0.312) at Baseline. At Follow-Up 1, the mean number of fatigue decreased to 0.146 in the intervention group, dropping lower than the control group, which increased slightly to 0.458. At Follow-Up 2, the mean number of fatigue increased slightly in the intervention group and decreased in the control group, as presented in Figure 4.11(a). Second, the mean number of muscle weakness in the intervention group (1.67E-1) was lower than in the control group (2.29E-1) at Baseline. At Follow-Up 1, the average number of muscle weakness in the intervention group went unchanged, but saw a great decrease to 8.33E-2 in the control group. In Follow-Up 2, in the intervention group, the mean number of muscle weakness greatly increased to 2.08E-1, while the control group greatly decreased to 1.04E-17, as shown Figure 4.11(b)

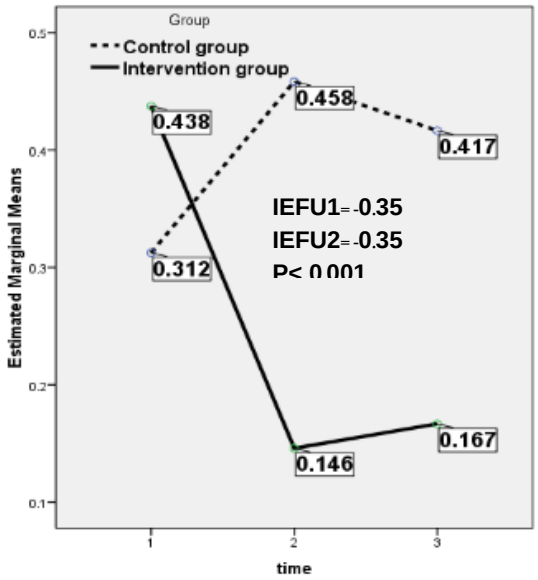


Figure 4.11 a Means of fatigue (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

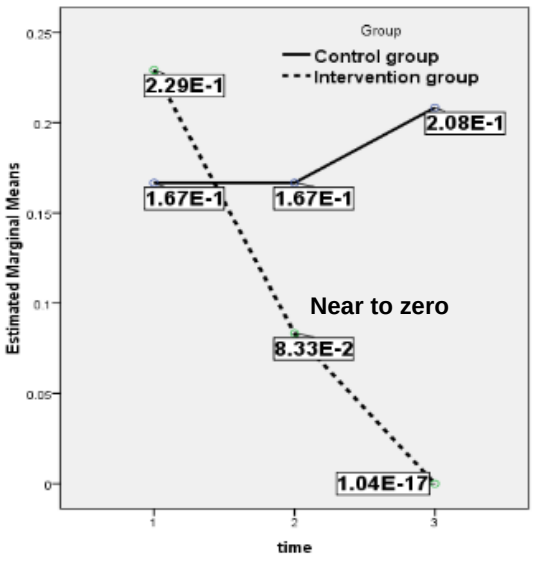


Figure 4.11b Means of muscle weakness (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

Skin system symptoms were also measured. At Baseline, the mean number of rash/itchy skin in the intervention group (0.208) was higher than in the control group (0.125). At Follow-Up 1, the mean number of rash/itchy skin in the intervention group decreased greatly to 0.062, dropping below that of the control group, which had greatly increased (0.333). At Follow-Up 2, the intervention group mean number decreased slightly to 0.042, but the control group number remained stable. See Figure 4.12.a

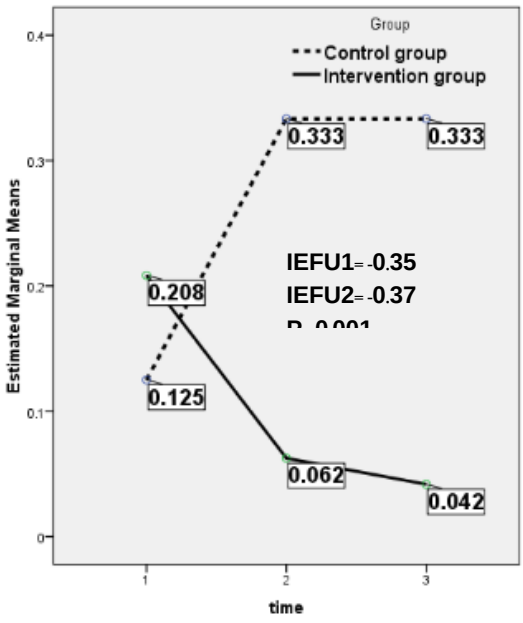
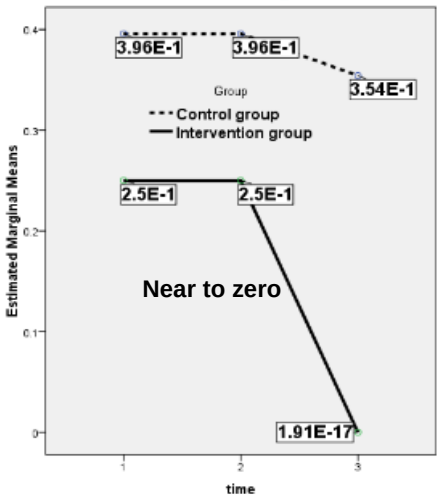


Figure 4.12 a Means of rash (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

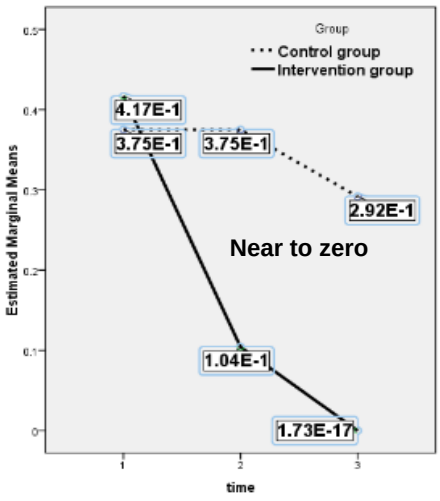
Neurological systems were also examined. First, the mean number of drowsiness in the intervention group (02.50E-1) was lower than in the control group (3.96E-1) at Baseline. At Follow-Up 1, the mean number of drowsiness in both the intervention and control groups was unchanged. At Follow-Up 2, the mean number of drowsiness decreased greatly in the intervention group (1.91E-17) and decreased slightly in the control group (3.64E-1), as shown in Figure 4.13(a). Second, the mean number of

dizziness in the intervention group (0.417) was higher than control group (0.376) at Baseline. At Follow-Up 1, the mean number of dizziness in the intervention group decrease significantly to 0.104 while remaining unchanged in the control group. In Follow-Up 2, the mean number decreased again in the intervention group (1.73E-17) and for the first time in the control group (0.292). See Figure 4.13(b). Third, at Baseline, the mean number of headaches in the intervention group (0.083) was lower than in the control group (0.104). At Follow-Up 1, the mean number of headaches decreased slightly in the intervention group to 0.062, while increasing greatly in the control group to 0.25. At Follow-Up 2, the mean number of headaches in the intervention group decreased once again to 0 occurrences, while the control group incidences increased greatly to 0.167, as seen Figure 4.13c). Fourth, the mean numbers of confusion and anxiety went unchanged in both groups across all times of measure, as seen Figures 4.13(d) and 4.13(e).



Baseline Follow-Up 1 Follow-Up 2

Figure 4.13 a Means of drowsiness (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)



Baseline Follow-Up 1 Follow-Up 2

Figure 4.13 b Means of dizziness (after working)in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

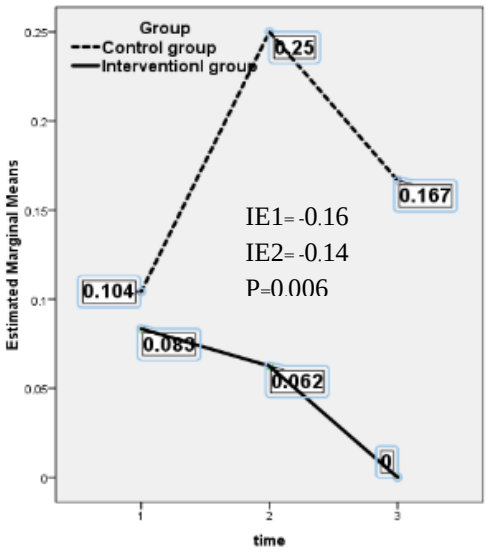


Figure 4.13 c Means of headaches (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

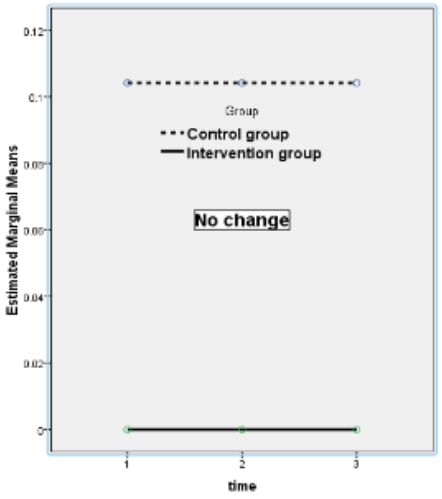


Figure 4.13e Means of confusion (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

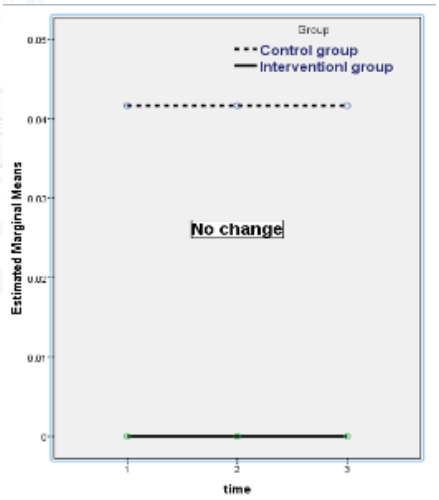


Figure 4.13 f Means of anxiety (after working)in intervention group and control group at Baseline, Follow-Up 1 and Follow-Up 2(GLM)

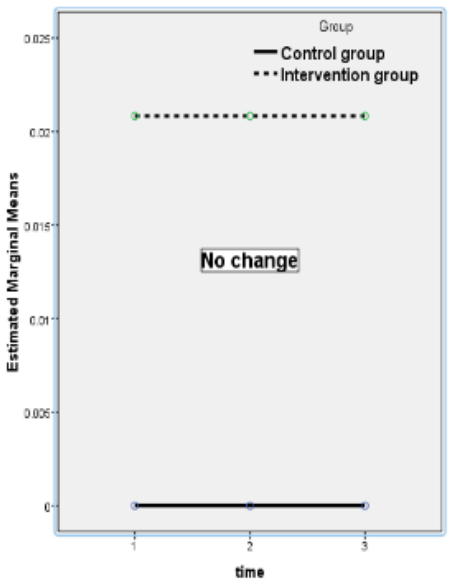


Figure 4.14a Means of vomiting (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

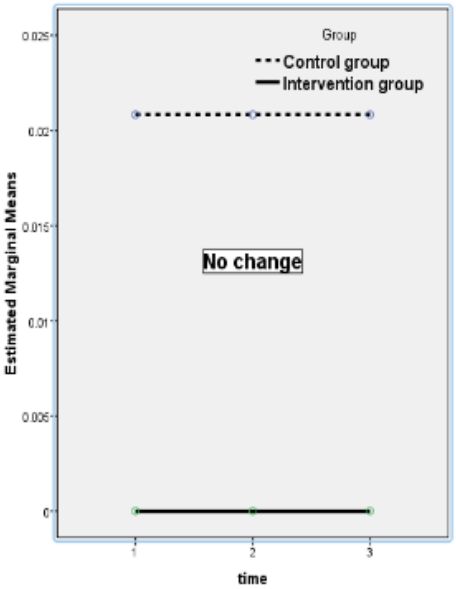
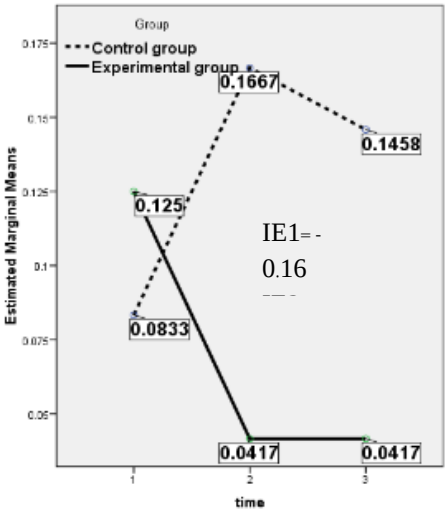


Figure 4.14 b Means of stomachaces (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLMt)

Digestive system symptoms were also examined, including vomiting, Stomachache and nausea. The mean number of vomiting and stomachache had no change in both groups as shown in Figure 4.14(a) and Figure 4.14(b). However, the mean number of nausea reported in the intervention group (0.125) was higher than in the control group (0.083) at Baseline. At Follow-Up 1, the mean number of nausea in the intervention group decreased significantly to 0.0417, dropping below that of the control group, which increase greatly to 0.1667. At Follow-Up 2, the mean number of nausea in the intervention group went unchanged, while the control group decreased to 0.145, as shown in Figure 4.14(c).



Baseline Follow-Up 1 Follow-Up 2

***Figure 4.14 C Means of nausea (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM* test)**

For respiratory systems, mean numbers of runny nose, sore throat, cough, wheezing, and difficult breathing followed a similar pattern, in that mean numbers of symptoms in the intervention group dropped lower than in the control group as the experiment was conducted. First, the mean number of runny nose in the intervention group (0.125) was higher than the control group (0.083) at Baseline. At Follow-Up 1, the mean number of runny nose in the intervention group decreased to 0.0417, but greatly increased in control group to 0.1667. At Follow-Up 2, the mean number of runny nose went unchanged in the intervention group and slightly decreased to 0.148 in the control group, as seen in Figure 4.15(a). Second, the mean number of sore throat in the intervention group (0.25) was higher than control group (0.188) at Baseline. At Follow-Up 1, the mean number of sore throat decreased greatly in the intervention group (0.021), but increased slightly in the control group (0.271). In Follow-Up 2, the average number

of sore throat slightly increased in the intervention group (0.062) and slightly decreased in the control group (0.188), as seen in Figure 4.15(b). Third, the mean number of cough in the intervention group (0.271) was lower than in the control group (0.292) at Baseline. At Follow-Up 1, the mean numbers of cough in both the intervention and control groups had decreased (0.062 and 0.312, respectively). In Follow-Up 2, it decreased slightly once again in both groups (0.042 and 0.26), as seen in Figure 4.15(c). Fourth, at Baseline, the mean number of wheezing in the intervention group (0.167) was lower than in the control group (0.188). At Follow-Up 1, the mean number of wheezing decreased greatly in the intervention group to 0.063, while it increased slightly in the control group (0.292). At Follow-Up 2, the mean number of wheezing slightly decreased in both the intervention and control groups, to 0.042 and 0.25, respectively. See Figure 4.15(d). Finally, the mean numbers of difficult breathing in the intervention group (0.083) and in the control group went unchanged between Baseline and Follow-Up 1. At Follow-Up 2, the mean number of difficult breathing in the intervention group increased significantly to 0.146, whereas this number decreased greatly to 0.042 in the control group. See Figure 4.15(e).

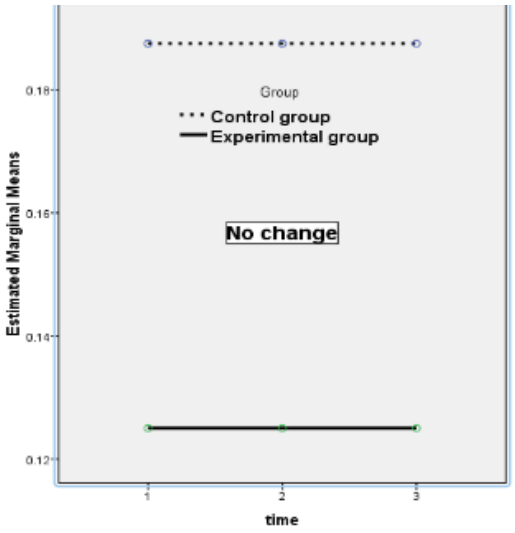


Figure 4.15 a Means of runny nose (after working) in intervention group and control groupat Baseline, Follow-Up 1 and , Follow-Up 2

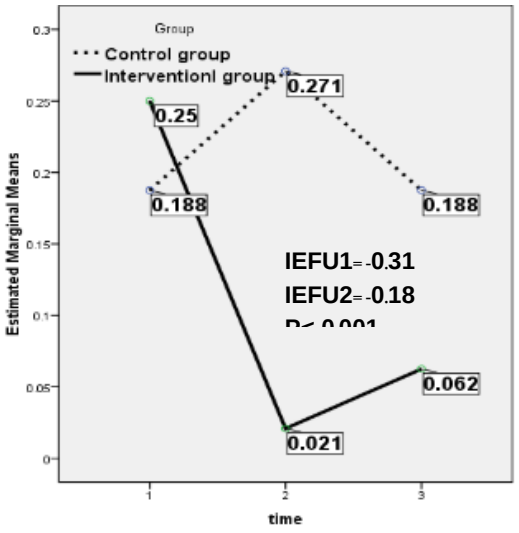


Figure 4.14(b) Means of sore throat (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2

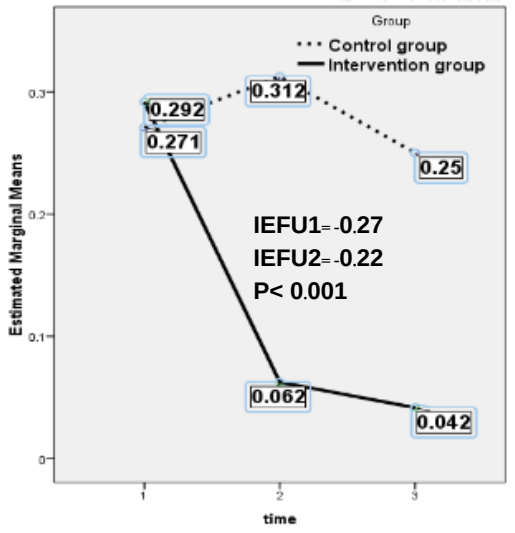


Figure 4.15 c *Means of cough (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)*

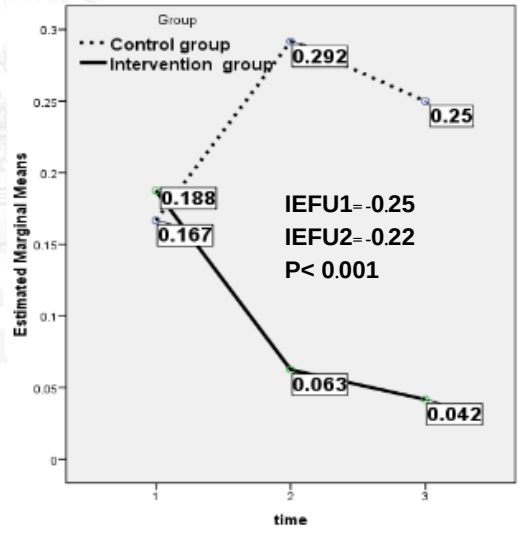


Figure 4.15 d Means of wheezing (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2(GLM)

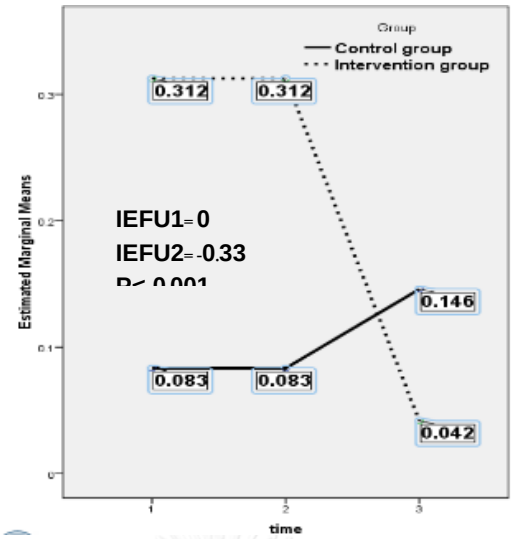


Figure 4.15 e Means of difficult breathing (after working) in intervention group and control group at Baseline, Follow-Up 1 and , Follow-Up 2 (GLM)

There were statistically highly significant differences between mean numbers of health symptoms by organs systems, including eye and facial irritation, skin, muscular, and respiratory systems among VCOs. However, there was no change in runny nose, confusion, anxiety, vomiting, and stomachaches, as shown in Table 4.11. The IE of a safety chemical program on improving the operators' health is expressed as magnitude of intervention effect. For eye, facial, and skin symptoms, including facial burning, paresthesia, blurred vision, and rash/itchy skin, intervention effects at Follow-Up 1 (IEFU1) saw a reduction in mean symptoms in the intervention group greater than in the control group. IEFU1 was -0.16, -0.12, -0.33, -0.25 and -0.35, respectively. IEFU2 was -0.14, -0.18, -0.33, -0.25 and -0.37, respectively.

For muscular systems, the intervention group saw a greater decrease in fatigue than in the control group; IEFU1 was -0.35 and IEFU2 was -0.35.

For headaches, the intervention group saw a greater reduction than control group in IEFU1 only (0.16). Sore throat, cough, wheezing, and difficult breathing also saw greater reduction in the intervention group than in the control group; IEFU1 was -0.31, -0.27, -0.25 and 0 and IEFU2 was -0.18, -0.22, -0.22 and -0.33, respectively. See Table 4.11

4.4.4.2 Intervention effects of dichotomous variables (health symptoms) after working with model for time and group interaction.

Generalized estimating equations with times and time interaction, Distrition= Poisson, Link= Identity were used for differences between intervention effects at Baseline, Follow-Up 1, and Follow-Up 2. Intervention effect had a reduced prevalence in eye and facial systems (facial burning, paresthesia, blurred vision, itchy/scratchy eye), skin systems (rash/itchy skin), muscle systems (fatigue), digestive systems (nausea), and respiratory systems (runny nose, sore throat, cough, and wheezing) at Follow-Up 1 and Follow-Up 2 with p value < 0.05 when compared with the control group. However, the model did not run successfully for muscle weakness, drowsiness, headaches, confusion, anxiety, vomiting, stomachache and difficult breathing due to zero prevalence in one or more groups, as shown in Table 4.13

Table 4. ***13 Overall effectiveness (intervention effects) of safety chemical program on improvement in the operators' health situation after spraying among intervention and control groups at Baseline, Follow-Up 1 and Follow-Up 2.***

Health symptoms	IEFU1	IEFU2	F	Hypothesis df	Error df	*p*-value
Eye and facial						
Facial burning	-0.16	-0.14	4.30	2	93	0.016
Paresthesia	-0.12	-0.18	5.44	2	93	0.006
Blurred vision	-0.33	-0.47	14.66	2	93	<0.001
Itchy/scratchy eye	-0.25	-0.26	6.04	2	93	0.003
Skin						
Rash/itchy skin	-0.35	-0.37	7.34	2	93	0.001
Muscular						
Fatigue	-0.35	-0.36	13.47	2	93	<0.001
Muscle weakness	*	*	5.32	2	93	0.006
Neurological						
Drowsiness	*	*	8.96	2	93	0.004
Dizziness	*	*	11.22	2	93	<0.001
Headaches	-0.16	*	5.37	2	93	0.006
Confusion	No change	No change	*	*	*	*
Anxiety	No change	No change	*	*	*	*
Digestion						
Nausea	-0.16	-0.14	3.34	2	93	0.039
Vomiting	No change	No change	*	*	*	*
Stomach ache			*	*	*	*
Respiratory	No change	No change				
Runny nose	No change	No change	*	*	*	*
Sore throat	-0.31	-0.18	9.27	2	93	<0.001
Cough	-0.27	-0.22	7.88	2	93	<0.001
Wheezing	-0.25	-0.22	8.28	2	93	<0.001
Difficult breathing	*	-0.33	20.39	2	93	<0.001

Note. General Linear Model repeated-measure ANOVA (Wilks'' Lambda from multivariate test)

* Model did not run due to zero prevalence in one or more groups

IEFU1 = difference of mean of symptoms prevalence in intervention group (Baseline - Follow-Up 1) minus difference of mean symptoms prevalence in control group (Baseline -Follow-Up 1)

IEFU2 = difference of mean of symptoms prevalence in intervention group (Baseline - Follow-Up 2) minus difference of mean symptoms prevalence in control group (Baseline - Follow-Up 2

Table 4. ***14 Absolute magnitudes of intervention effects in prevalence of health symptoms after working compared to Baseline prevalence***

	Intervention effects			
	Follow-Up 1		Follow-Up 2	
Health symptom	**Magnitude (95%CI)**	***p-value***	**Magnitude (95%CI)**	***p-value***
Eye and facial				
Facial burning	-0.16 (-0.27,-0.05)	0.003	-0.14 (-0.31,0.02)	0.103
Paresthesia	-0.12 (-0.22,-0.02)	0.011	-0.18 (-0.30,-.07)	0.002
Blurred vision	-0.33 (-0.48,-0.18)	<0.001	-0.47 (-0.65,-0.30)	<0.001
Itchy/scratchy eye	-0.25 (-0.40,-0.09)	0.002	-0.25 (-0.39,-0.10)	<0.001
Skin				
Rash/itchy skin	-0.35 (-0.55,-0.15)	<0.001	-0.37 (-0.56,-0.18)	<0.001
Muscular				
Fatigue	-0.35 (-0.55,-0.15)	<0.001	-0.35 (-0.56,-0.18)	<0.001
Muscle weakness	*	*	*	*
Neurological systems				
Drowsiness	*	*	*	*
Dizziness	*	*	*	*
Headaches	*	*	-0.16 (-0.27,-0.05)	0.002
Confusion	*	*	*	*
Anxiety	*	*	*	*
Digestion				
Nausea	-0.16 (-0.29,-0.42)	0.009	-0.14 (-0.26,-27)	0.016
Vomiting	*	*	*	*
Stomach ache	*	*	*	*
Respiratory				
Runny nose	*	*	*	*
Sore throat	-0.31 (-0.45,-0.17)	<0.001	-0.18 (-0.29,-0.07)	<0.001
Cough	-0.27 (-0.40,-0.13)	<0.001	-0.22 (-0.44,-0.13)	<0.001
Wheezing	-0.25 (-0.38,-0.11)	<0.001	-0.22 (-0.36,-0.09)	<0.001
Difficult breathing	*	*	-0.33 (-0.476,-0.19)	<0.001

Note. Generalized estimating equations with times and time interaction, (Distrition=Poisson, Link = Identity)

* Model did not run due to zero prevalence in one or more groups

4.4.5 Effectiveness of improving the operators' health of none working

Health workers symptoms prevalence was very few, so researcher did not measure this section.

4.4.6 Effectiveness of improving the operators' health (lung function test).

The effectiveness of improving lung function in VCOs was measured as Forced Vital Capacity (L) (FVC), Forced Expiratory Volume in one second (L) FEV1, FEV1/FVC (%), Maximum Mid Expiration Flow (MMEF) (%), Force Expiratory Time (FET)(second), and Peak Expiratory Flow (PEF) (L/m). Lung function was assessed after 12 hours of spraying in both control and intervention groups at Baseline and Follow-Up 1. See Table 4.14 and Figure 14.6 a-14.6 f

Mean of FVC in the intervention group (3.804) was higher than in the control group (3.572). In Follow-Up 1, mean of FVC increased more in the intervention group (4.007) than in the control group (3.894), as shown in Figure 4.16(a)

Mean of FEV1 in the intervention group (3.264) was higher than in the control group (3.048). In Follow-Up 1, mean of FEV1 increased more in the intervention group (3.43) than in the control group (3.307), as shown in Figure 4.16(b)

Mean of %FEV1/FVC, in the intervention group (85.13) was higher than in the control group (85.03) at Baseline. In Follow-Up 1, mean of %FEV1/FVC increased in the intervention group (85.77), with a greater than in the control group (85.61). See Figure 4.16(c)

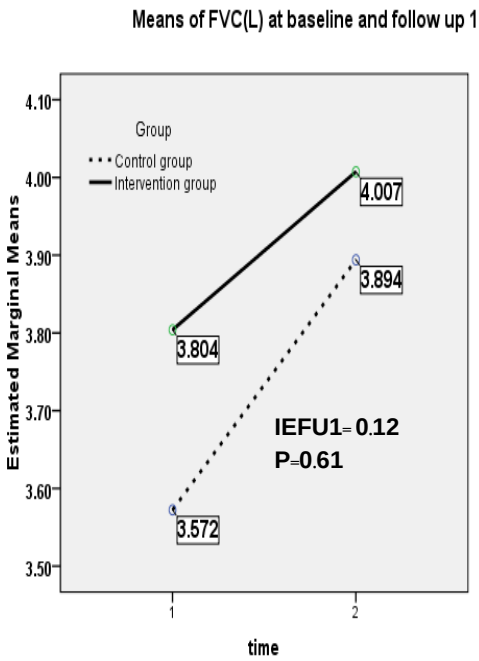


Figure 4.16 a Means of FVC in intervention group and control group at Baseline and Follow-Up 1 (GLM)

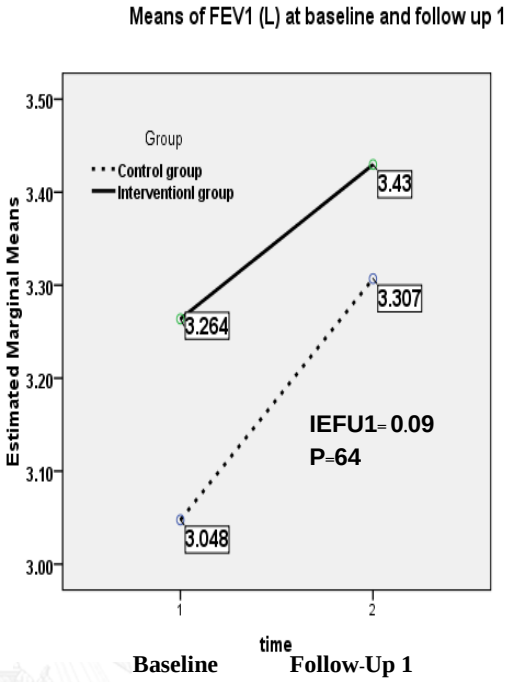


Figure 4.16 b **Means of FEV1 in intervention group and control group at Baseline and Follow-Up 1 (GLM)**

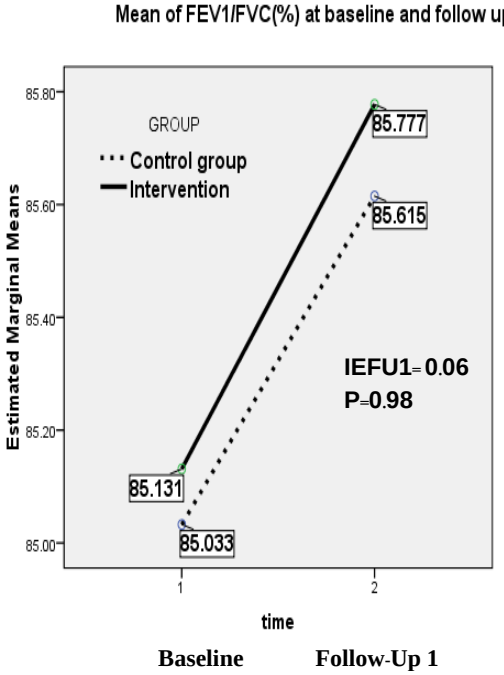


Figure 4.16 C Means of FEV1/FVC(%) in intervention group and control group at Baseline and Follow-Up 1 (GLM)

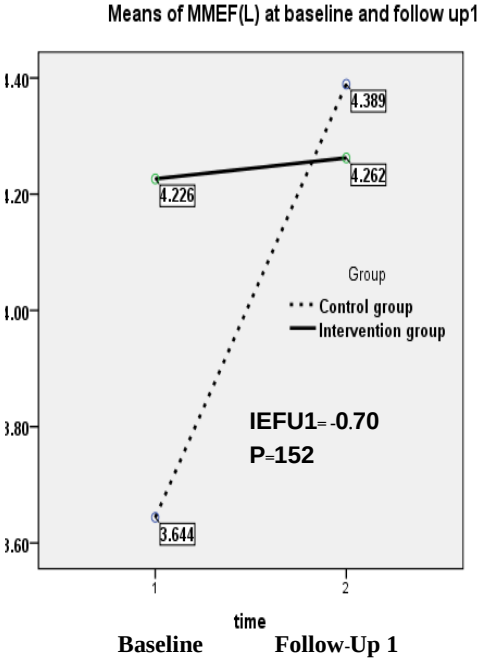


Figure 4.1* 6 d *Means of MMEF in intervention group and control group at Baseline and Follow-Up 1 (GLM)

Mean of MMEF in the intervention group (4.22) was higher than in the control group (3.64) at Baseline. In Follow-Up 1, mean of MMEF had slightly increased in the intervention group (4.26) but was lower than in the control group (4.38), as shown in Figure 4.16(d)

Mean of FET in the intervention group (6.02) was higher than in the control group (5.93) at Baseline. In Follow-Up 1, mean of FET had increased greatly in the intervention group (8.61), but only slightly in the control group (6.51), as shown in Figure 4.16(e)

Mean of PEF in the intervention group (8.46) was higher than in the control group (7.88) at Baseline. In Follow-Up 1, mean of FET had decreased greatly in the intervention group (6.25), while decreasing in the control group (6.52). See Figure 4.16(f)

Table 4. ***15 Intervention effect of a safety chemical program on improving lung function at Baseline and Follow-Up 1***

Parameter	Baseline		Follow-Up 1		Intervention effect	
	Control group (n=35)	Intervention Group (n=29)	Control group (n=32)	Intervention Group (n=28)	Magnitude	*P value
FVC(L)	3.572	3.804	3.894	4.007	-0.12	0.614
FEV1(L)	3.048	3.264	3.307	3.43	-0.09	0.645
FEV1/FVC (%)	85.03	85.13	85.61	85.77	0.06	0.98
MMEF(L)	3.64	4.22	4.38	4.26	-0.70	0.152
FET(second)	5.93	6.02	6.51	8.61	2.01	0.087
PEF(L/m)	7.88	8.46	6.52	4.95	-2.15	0.017

Note. General linear model (Wilks' Lambda test from Multivariate test)

Intervention effect = (Baseline- Follow-Up 1) $_{intervention}$ - = (Baseline- Follow-Up 1) $_{control}$

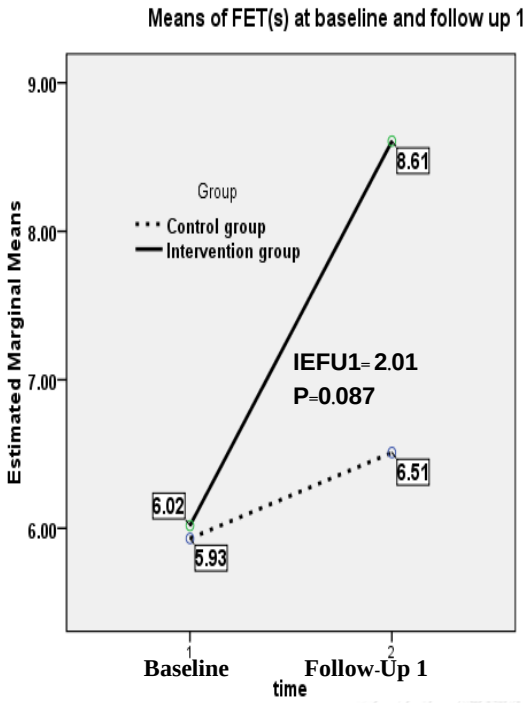


Figure 4.16 e Means of % FET in intervention group and control group at Baseline and Follow-Up 1 (GLM)

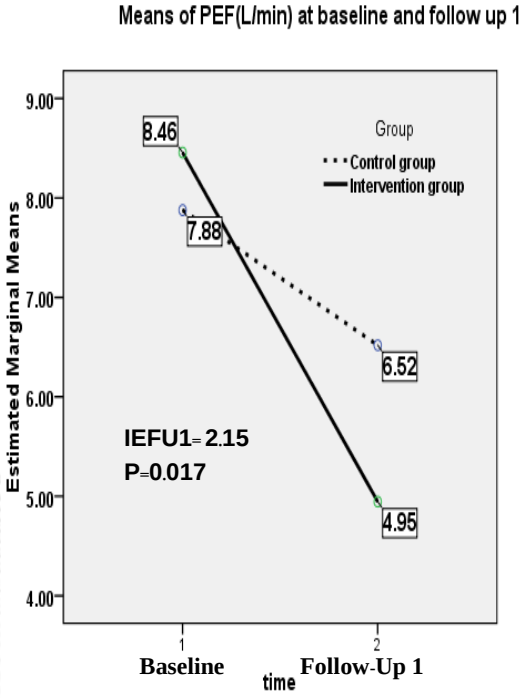


Figure 4.16 f Means of % PEF in intervention group and control group at Baseline and Follow-Up 1 (GLM)

The General Linear Model repeated-measures was used to assess overall effectiveness of a safety chemical program on improving lung function in VCOs as Forced Vital Capacity (L) (FVC), Forced Expiratory Volume in one second (L) FEV1, FEV1/FVC (%), Maximum Mid Expiration Flow (MMEF) (L), Force Expiratory Time (FET)(second), and Peak expiratory flow (PEF) (L/m). There were no significant differences in FVC (p value 0.614), FEV1 (p value 0.645), FEV1/FVC (p value 0.98), MMEF (p value 0.152) and FET (p value 0.087) in the intervention group as compared to the control group. However, PEF had a significant difference in the intervention group as compared to the control group at *p-value* 0.017. Intervention effects for FVC,

FEV1, FEV1/FVC, MMEF, FET, and PEF were -0.12, -0.09, 0.06, -0.70, 2.01 and -2.15, respectively. See in Tables 4.15 and 4.16.

Table 4. ***16 Overall effectiveness of a safety chemical program on improving lung function at Baseline and Follow-Up 1***

Parameter	**F**	**Hypothesis df**	**Error df**	***p-value***
FVC(L)	0.25	1	58	0.614
FEV1(L)	0.214	1	58	0.645
FEV1/FVC (%)	0.01	1	58	0.98
MMEF (%)	2.10	1	58	0.152
FET (second)	3.04	1	58	0.087
PEF (L/m)	6.03			0.017

Note. Repeated-measures analysis of variance (Wilks' Lambda test from Multivariate test)

General Linear Mixed Model was used to analyze the effectiveness of a safety chemical program on improving lung function at Baseline and Follow-Up 1. Results found FVC, FEV1, FEV1/FVC, MMEF, FET, and PEF were not significantly different at *p*-values 0.54, 0.58, 0.83, 0.16 and 0.10, respectively. However, PEF was significantly different in the intervention group as compared to the control group at *p*-value 0.01, as shown in Table 4.16.

Table 4. ***17 Effectiveness of a safety chemical program on improving lung function for the interaction effect of time and intervention at Baseline and Follow-Up 1.***

Parameter	Estimate	Std. Error	df	t	*P-value**	95% Confidence Interval	
						Lower	Upper
FVC(L)	-0.1428	.2328	58	-0.613	0.542	-0.6089	0.3232
FEV1(L)	-0.1104	0.2016	58	-0.548	0.586	-0.5140	0.2931
FEV1/FVC(%)	-0.4816	2.2502	58	0.446	0.83	-4.9810	4.0178
MMEF(%)	-0.6800	0.4842	58	-1.404	0.165	-1.6487	0.2886
FET(second)	1.8515	1.1138	58	1.662	0.101	-0.3746	4.0777
PEF(L/m)	-2.1179	0.8642		-2.451	0.017	-3.8462	-0.38951

Note. General linear mixed model (Estimates of Fixed Effects

CHAPTER V

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

The aims of this study were to determine the effectiveness (intervention effects) of a chemical safety program on improving VCOs health in Bangkok, Thailand by measuring 1) biological exposure indices (BEIs) as 3 phenoxylbenzoic acid (3-PBA) for cypermethrin, trans,trans-muconic acid (tt-MA) for benzene, and o-Cresol for toluene, 2) respiratory symptoms (during work and after working), 3) safety behavior score before and after intervention program among intervention and control groups ,4) lung function test as FVC, FEV1, %FEV1/FVC, MMEF, FET, and PEF. Baseline measurements were taken and the first follow-up session (Follow-Up 1) was performed March 2, 2016 to May 3, 2016. The second follow-up session (Follow-Up 2) was performed July 2, 2016 to October 3, 2016. The goal was to assess cypermathrin, benzene, and toluene personal exposure and investigate occupational risk factors associated with workers' health symptoms. This chapter summarizes and discusses conclusions, clarifying reasons for study findings as well as comparing and contrasting between other studies.

5.1 Summary of Research Findings and Discussion

5.1.1 Airborne cypermathrin, benzene, and toluene personal working exposure and their metabolite.

In our study, the average concentration of cypermethrin among the 96 VCOs spraying for mosquitos was 0.005±0.002 ppm or 85 ug/m^3±32ug/m^3. The cypermethrin exposure sampled in this study was higher than in previous studies. International Program for Chemical Safety(1992) conducted studies on workers from Durban, South Africa and showed alpha-cypermethrin exposure levels of 2.8-4.9 µg/m^3. Zhang, Sun, Chen, Wu, and He (1991) reported that pesticide-spraying operators exposed to deltamethrin had levels of 0.01-0.89 µg/m^3 in the breathing zone. However, most previous studies focused on outdoor spraying activities. In this study, over half of the VCOs (59.4%, n=57) sprayed indoors.

The findings regarding 3-PBA levels in urine, a biomarker of cypermethrin, of 5.00±2.42 ug/g creatinine were consistent with Hardt and Angerer (2003), who conducted among indoor pest control operators. Our finding found the benzene concentration in the air was greater than NIOSH recommendations (NIOSH REL) of Ca TWA 0.1 ppm. Results from this study were similar to those of Moolla, Curtis, and Knight (2015), who indicated that benzene concentrations from diesel exceeds the Environmental Protection Agency (EPA) inhalation standard reference concentration. However, tt-MA as a metabolite of benzene exposure in urine was not higher than the biological exposure indices standard of the American Conference of Government

Industrial Hygienist ((ACGIH), 2007), which recommended the biological exposure indices standard at the end of shift to be 500 ug/g creatinine. Operators' exposure to toluene and o-cresol was not higher than the occupational exposure limits set by the ACGIH recommendations.

MacFarlane et al. (2007) reported that pest and vector control operators could be exposed to various hazardous chemicals while mixing, loading, and spraying. The findings of this study show that cypermethrin exposure was linked to facial irritation, itchy eyes, blurred vision, drowsiness, and dizziness (p□0.05). These findings were consistent with Zhang et al. (1991).

This study also found that benzene exposure was associated with itchy eyes, fatigue, and dizziness. Toluene exposure was found to be associated with facial irritation, paresthesia, itchy eyes, blurred vision, dizziness, headaches, and nausea. These findings were consistent with the Grasso, Sharratt, Davies, and Irvine (1984) studies, which stated that neurophysiological and psychological disorders could occur as a result of exposure to solvents. Our results showed that 63 operators (65.3%) were not wearing chemical masks while working.

5.1.2 Association between occupational risk factors and VCOs' health.

This study adjusted for age, smoking, drinking, processed food consumption, time spent spraying, regular use of personal protective equipment (PPE), indoor spraying, chemical exposure, and metabolites, and used logistic regression models to analyze data. Results indicated that VCOs not using PPE regularly had greater adjusted

odds ratio for facial irritation, sore throat, and fatigue than the other factors. Indoor spraying resulted in higher probability of paresthesia, blurred vision, and headaches. Time spent spraying resulted in the highest difficulty breathing. In addition, results showed that 71 VCOs (74%) who did not use PPE regularly and were exposed to cypermethrin had a higher probability of face irritation, eye irritation, difficulty breathing, and drowsiness. Similarly with Zhang et al. (1991) found that cotton farm workers exposed to pyrethroid could develop various health symptoms such as facial sensations, dizziness, headache, fatigue, and nausea.

Operators who sprayed at indoor locations and were exposed to toluene were more likely to be afflicted with paresthesia and blurred vision. This finding was similar to van der Jagt, Tielemans, Links, Brouwer, and van Hemmen (2004), who indicated that airplane passengers and crew often complained of eye irritation due to residual permethrin after emulsion spraying for aircraft disinfection, as these products were found to contain volatile organic compounds in all aerosol preparations. Our study found that operators exposed to benzene and toluene experienced dizziness. This is consistent with Lee, Pai, Chen, and Guo (2003), who indicated that workers with chronic toluene exposure developed palpitations, insomnia, and dizziness with headaches. This study also found that operators exposed to benzene while spraying experienced fatigue, a finding consistent with Tunsaringkarn (2012), and Moura-Correa et al. (2014) who indicated that workers exposed to benzene were significantly associated with symptoms of fatigue.

5.1.3 Effectiveness (intervention effects) of a chemical safety program on improving VCOs health.

96 VCOs met inclusion criteria and participated in this study. There were 48 operators in the intervention group from North Bangkok, South Bangkok, and East Bangkok and 48 operators in the control group from North Klongthon, South Klongthon, and Central Bangkok. Both groups were of similar socio-demographic characteristics, thus this study did not adjust independent variables for control confounding factors that can affect results of outcomes. All participants were male, and average age of the intervention group and the control group were 42.1 (10.2) and 41.2 (10.95) years old, respectively (p=0.74). Most participants in both groups graduated secondary school (p=0.054). The average work experience of operators in intervention and control groups were 11.21 (8.83) and 11.4 (7.90) years, respectively (p=0.92). There were no significant differences between groups in personal factors, such as number of participants who smoke (p=0.089), drink (p=0.77) and consumption of processed food (p= 0. 112), respectively. Working conditions in terms of duration of spraying insecticides were not different between the groups (p=0.112); they usually spray more than 3 hours per day. Most operators were spraying in indoor areas: 58.3 % in the intervention group and 60.4 % in the control group (p=0.835). Almost all participants (81.2 % in the intervention group and 66.7 % in the control group) reported that they do not use PPE while working (spraying and mixing). There was no significant difference in PPE usage between groups (p=0.162).

Operators in this study were older and had more average work experience than those in the Wang et al. (2007) studies on pest control workers in Japan, where the average age was 36.0 (11.0) years and exposure durations were 8.6 (7.7) years. In our study found operators had sprayed more than 3 hours per day.

The intervention consisted of a chemical safety training program including 1) meeting the environmental health staff and VCOs to explain the project, its objective, data collection, and brainstorming to find collaboration, 2) training of basic chemical safety, including chemical toxicity, health hazards, safe handling, mixing, and spraying, and PPE usage 3) medical examinations, occupational health and chemical exposure symptom information distribution, and recommendation on how to prevent disease and symptoms 4) providing the proper PPE and fit test program practices for chemical mask use and 5) providing a chemical safety for VCOs booklet.

The intervention program outcomes were measured three times to determine effective, as Baseline, Follow-Up 1, and Follow-Up 2. The measuring consisted of 4 categories, including 1) safety behavior such as PPE usage, chemical safety practice using questionnaire of 5 point Likert scale) 2) biological monitoring in urine after spraying 3).health symptom questionnaire (during and after working) and 4).the spirometric lung function test was administered only twice, and Baseline and Follow-Up 1.

For chemical safety score measured, after intervention program found means safety score in the invention group were high significantly increased than the control group at both Follow-ups, so this study can imply that intervention program had effected to improve chemical safety behavior among VCOs. Similar Sam et al. (2008) studies found that education program can lead to increase KPI score for safety pesticide

handling among farmers. In addition, this study consist with Boonyakawee, Taneepanichskul, and Chapman (2013) states that integrate intervention program with intended to teach to workers and practice demonstrate, pesticide exposure monitoring and continuous given safety information can significantly improve knowledge and practices score. Several reasons this study had successes to improve chemical safety behavior score duo to researcher was training base on practices training in field working conditions with provide proper PEE and safety working instruction. Moreover, VCOs were received medical occupational examination by occupation medicine with biological monitoring.

For biological monitoring of metabolite, 3 phenoxylbenzoic acid (3-PBA) for cypermethrin, trans,trans-muconic acid(tt-MA) for benzene, and o-Cresol for toluene were measured. Intervention effectively reduced metabolite (3-PBA, tt-MA and o-Cresol) in the intervention group at both Follow-Up 1 and Follow-Up 2 when compared with control group. However, intervention effects of tt-MA and o-Cresol had slight increased at Follow-Up 2. It may be effects from chemical cartridge had low efficiency VCOs due to humidity can cause activated carbon contained in water vapor (Nelson, Correia, & Harder, 1976). Findings were consistent with the study done by Van et al. (2004), which examined the effectiveness of PPE on dermal and inhalation exposure to chlorpyrifos among pest control operators. The PPE program had significantly reduced metabolite (TCP levels) in urine before onset of spraying activities. Keifer (2000) also found that PPE was effective in reducing pesticide exposure among workers.

The chemical safety program effectively reduced at during work, the prevalence of eye and facial symptoms (facial burning, paresthesia, blurred vision), skin symptoms (rash/itchy skin), muscular symptoms (fatigue and muscle weakness), neurological symptoms (drowsiness and headaches), and respiratory symptoms (runny nose) as compared to the control group at Baseline, Follow-Up 1, and Follow-Up 2. However, cough, wheezing, and difficult breathing were only affected greater in the intervention group than the control group at Baseline to Follow-Up 2. Intervention also effectively reduced, after work, the prevalence of eye and facial symptoms (facial burning, paresthesia, blurred vision, itchy/scratchy eye), skin symptoms (rash/itchy skin), muscle symptoms (fatigue), digestive symptoms (nausea), and respiratory symptoms (runny nose, sore throat, cough, and wheezing) at both Follow-Up 1 and Follow-Up 2, with a p value < 0.05, when compared to the control group. Intervention effectively reduced prevalence of symptoms, particularly facial and skin and eye symptoms, because it provided proper PPE (hats, goggles, and clothing) and training on usage to protect from chemical exposure. However, some respiratory symptoms prevalence (cough, wheezing and difficult breathing) was only reduced more in the intervention group than the control group at Follow-Up 2. Most operators in the intervention group were unaccustomed to using chemical masks or respirator, so they were uncomfortable and needed to get acclimated to usage. This findings is similar to Ye (2003), who studied occupational pesticide exposures and respiratory health and found that educational programs on safety precautions, especially the proper use of PPE, were effective approaches for

preventing respiratory symptoms and diseases related to occupational pesticide exposures.

For lung function tests in operators found no significant difference in FVC, FEV1,% FEV1/FVC, MMEF, and FET between in intervention and control groups at Baseline and Follow-Up 1. Indeed, the intervention was associated with a significant adverse effect on PEF. Therefore, the chemical safety program intervention did not effectively improve spirometric lung function among operators. Similar results have been studied by Bernardes, Chiavegato, de Moraes, Negreiros, and Padula (2015), who found that lung function differences among foundry workers were not significant between exposed and non-exposed workers, as determined using effective risk control measures. Moreover, these findings were consistent with a study done by Thepaksorn, Pongpanich, Siriwong, Chapman, and Taneepanichskul (2013), who measured respiratory symptoms and patterns of pulmonary dysfunction among roofing fiber cement workers in the south of Thailand, and found both exposed and non-exposed workers had decreased pulmonary function. Intervention and control group had decreased lung function after intervention because, firstly, operators in intervention and control groups had been exposed chemicals for more than 11 years. In addition, Thepaksorn et al. (2013) found workers that have been exposed to chemicals for an average of only six years can develop pulmonary dysfunction. Second, Wang et al. (2007) found a positive correlation between PPE use and reduced FEV1 values. The World Health Organization (2007) stated that length of exposure is a factor in pulmonary

function and gas exchange disorders. Bernardes et al. (2015) found lung function test did not difference groups depend on age, time exposure and measure of working control health hazard. Chemical cartridge may be low efficiency VCOs due to humidity can cause activated carbon contains water vapor (Abiko, Furuse, & Takano, 2016).In addition, PPE regulation cannot eliminate risk factors because workers often refuse to use PPE (De Capitani & Algranti,2010). Finally, this study measured lung function only to Follow-Up 1 (6 months). This is a short time to observe lung function change. Moreover, smoking habit of participants might be affect lung function (Keman, Willemse, Wesseling, Kusters, & Borm, 1996).

This study found that Bangkok VCOs are a vulnerable population and face many risk factors to detrimental health symptoms. The results demonstrated that facial irritation, blurred vision, fatigue, and nausea were significantly associated with chemical exposure, biomarkers, the frequency of PPE use, and indoor spraying. In particular, indoor spraying and poor use of PPE may increase risks that could lead to health symptoms. After providing a chemical safety program, VCOs saw significant improvements in health via reduced biomarkers in urine (3-PBA, tt-MA and o-Cresol), improvement of health symptoms during working and after work, including reduced prevalence of symptoms in eye and facial systems (facial burning, paresthesia, and blurred vision), skin systems (rash/itchy skin), neurological systems, muscular systems (fatigue, drowsiness, and headaches) and respiratory systems (runny nose) over the control group at Baseline, Follow-Up 1, and Follow-Up 2. However, some respiratory

symptoms prevalence (cough, wheezing, and difficult breathing) only decreased more in the intervention group than the control group by Follow-Up 2. This might be due to most operators in the intervention group being unaccustomed to using chemical masks. Moreover, Follow-up1 measured in rainy seasons, operators might be get a cold. For the chemical safety program did not effectively improve lung function tests among operators. This might be because participants have been exposed chemicals for a long time, leading to development of pulmonary dysfunction, low efficiency chemical cartridges due to expose humidity while chemical spraying, or VCOs disregard of PPE usage. Overall, the chemical safety program in this study had effectively improved safety behavior among Bangkok VCOs.

5.2 Limitations

5.2.1 This study was conducted using a purposive sampling technique to select participants, and therefore lacked random sampling into the intervention group and control group. Therefore, this study cannot be used for generalization of a larger population such as all VCOs in Thailand. It more accurately represents VCOs who have been working only with Bangkok city or local government.

5.2.2 Cross contamination/information sharing between the intervention and control groups was unable to be controlled, since VCOs in Bangkok are able to contact and shared information with each other via social media, such as Facebook and other online application. This may impact outcomes.

5.2.3 Self-reporting could result in the inability to recall events, and questionnaire participants could answer by over- or underestimating. These factors may reduce the reliability of responses.

5.2.4 Time spent spraying indoors versus outdoors was not included as a factor in this study. Operators were only asked about overall time spent spraying, which may be a confounding factor.

5.2.5 Human error occurred by VCOs during first void urine sampling. Some VCOs did not collect their first urine or they collected urine more than 12 hours after chemical spraying, leading to very low findings of 3-PBA (metabolite of cypermethrin).

5.2.6 Quality control (% recovery) of 3PBA analysis is only 85-106, leading to interpreted the results 3-PBA concentration.

5.3 Recommendations

This study found that VCOs are a vulnerable population that faces many risk factors leading to detrimental health symptoms. The results demonstrated that facial irritation, blurred vision, fatigue, and nausea were significantly associated with chemical exposure, biomarkers, the frequency of PPE use, and indoor spraying. In particular, indoor spraying and poor use of PPE may increase risks that could lead to health issue symptoms. The findings suggest that the introduction and implementation of chemical safety programs could reduce chemical exposure and symptoms among

VCOs. Particularly, the owner (Bangkok Metropolitan Administration, BMA) should provide proper PPE, including chemical cartridges, goggles, ear plugs, body clothing, rubber gloves, and rubber boots, as well as fit testing and training on using and maintaining. PPE training for VCOs, along with improving safe and hygienic work conditions, such as adding hazard warnings and safety signs, installing eye showers and bathrooms, can all be beneficial. In addition, owners should provide VCOs medical examinations by occupational health officers and biological monitoring for occupational health surveillance. The Occupational Safety, Health and Environmental Act, 2554 (A.D.2011) stated in Chapter 1 (ASEAN-OSHNET,2017) that employers are to provide employees safe and hygienic work conditions and environment, and employer shall be responsible for the expenditure related to such provision. However, in this study, VCOs were unaccustomed to using chemical mask. Thus, intervention programming should add time to practice chemical mask usage by increasing the percentage of PPE wearing time/time working for VCOs to become accustomed to using PPE. Moreover, before wearing a chemical mask, VCOs should take a medical evaluation, because chemical masks or respirators can be hazardous to operators who have heart and lung problems.

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APPENDIX

Appendix A

Interview forms

Questionnaire of general characteristics, personal behavior, medical history, working and exposure characteristics and health symptoms among Vector Control Operators

Participant's No.....Date.....Start-End Time.....
District....., Bangkok, Thailand

Introduction of the questionnaire

1. The aims of this interview, we would like to ask some information about occupational pesticide exposure. The information you provide may help us to prevent occupational health disease and acute symptom due to exposure to pesticide of Vector Control Operators in Bangkok.
2. Your participation is voluntary, and you may skip any questions which you do not want to answer.
3. The questionnaire is divided into 3 part as follows:
   Part 1 General data , personal behavior, medical history
   Part 2 Working and exposure characteristics
   Part 3 Health symptoms
4. Please select(/) the answer for each question
5. "Chemical" in this study mainly focuses on pesticide and diesel fuel

Part 1: General data, personal behavior, medical history

Instruction: Please answer the questions in the space provide or choose the answer by marking (/) in the relevant brackets

1. Age.....Years
2. Gender ( ) 1. Male ( ) 2.Female
3. Weight.....kgs. Height.....cm
4. Highest Education Level
   ( )1. Primary school ( ) 2.Secondary school (M1-M3)
   ( )3.Secondary school (M4-M6) ( ) 4.Diploma
   ( )5.Higher than bachelor ( ) 6. Other.....

5. Have you ever been smoking?
   ( ) 1.Yes ( ) 2. No
   If "Yes". How long are you smoke.....years
6. How old are you smoking?.....years
7. Do you smoking now
   If "NO",How old are you stop smoking .....years
   ( ) 1.Yes ( ) 2. No
8. What is cigarette number that you are smoke each day? .....sticks
9. Have you ever been drinking?
   ( ) 1.Yes ( ) 2. No
   If "Yes". How long are you drinking.....years
10. How old are you start drinking?.....years
11. Do you drinking now
    If "NO",How old are you stop drinking .....years
    ( ) 1.Yes ( ) 2. No
12. What is liquor number that you are drink each day?
    .....glasses other.....
13. Have a doctor told you that you have any follow illness (You can check more answer)
    ( ) Chronic lung disease
    ( ) Emphysema
    ( ) Bronchitis
    ( ) Asthma
    ( ) Lung cancer
    ( ) Hearth disease
    ( ) Hypertension
    ( ) Diabetic
    ( ) Stroke
    ( ) Other cancer

14. Are you usually take food such as fruit juices, cake, jelly or cheese?
    ( ) Yes ( ) No

Part 2 Working and exposure characteristics

15. How long have you worked in Vector Control Operators..... years

16. Did the pesticide exposure occur while you were working?
    ( ) 1.Yes ( ) 2. No

17. What are you doing which most expose chemical ? (interviewer, mark only one from the list below .Do not read check list)
    ( ) Applying pesticide
    ( ) Mixing/loading pesticide
    ( ) Transport/Disposal pesticide
    ( ) Repair and maintenance pesticide equipment
    ( ) Routine work activities (exposure to field residue)
    ( ) Routine indoor activities (exposure to home used pesticide)

18. How long have you working time hour per days for pesticide spraying (hr/day)
    ( ) 2 hr/day ( ) 3 hr/day ( ) 4 hr/day ( ) Other.....

19. What the most type of equipments was used in vector control? (interviewer, mark only one from the list below .Do not read check list)
    ( ) Pressurized can
    ( ) Aerosol generator
    ( ) Sprayer, backpack
    ( ) Sprayer line, hand-held
    ( ) Trigger pump/compressor air

20. What are active ingredient (interviewer ,find information from product pesticide label)

Active ingredient name	Percentage	Poisoning attribution

21. Were you wearing any personal protective equipment (PPE) ?
    ( ) 1.Yes ( ) 2. No

22. What PPE are wearing?

Type personal protective equipment(PPE)	Wearing	
	Yes	No
1.Chemical mask		
2.Filter or cotton mask		
3. Rubber /chemical boots		
4.Rubber /synthetic gloves		
5.clothing or leather gloves		
6.Chemical goggles /face shield		
7. Chemically resistant clothing (rubber apron, tyvek, rain gear)		

23. How often have you wearing PPE

Type personal protective equipment(PPE)	Wearing		
	Regularly	Once in a while	Never
1.Chemical mask			
2.Filter or cotton mask			
3. Rubber /chemical boots			
4.Rubber /synthetic gloves			
5.clothing or leather gloves			
6.Chemical goggles /face shield			
7. Chemically resistant clothing (rubber apron, tyvek, rain gear)			

24. Were you using engineering control? (eg closed mixing, loading system, exhaust ventilation)

( ) 1.Yes ( ) 2. No

Part 3 Health symptom

25. Do you have sign/symptom?

Sign/symptom	During working		After spraying		Not spraying	
	Yes	No	Yes	No	Yes	No
1) Facial burning						
2) Paresthesias/tingling or numness						
3) Itchy/scratchy eye, eye irritation tear come down						
4) Running nose						
5)Sore throat						
6) Rash/itchy skin						
7)Fatigue						
8) Muscle weakness						
9)Drowsiness						
10)Dizziness						
11)Headaches						
12)Confusion						
13)Anxiety/hyperactivity						
14)Blurred vision						
15)Nausea						
16) Vomiting						
17) Stomach ache						
18) Wheezing						
19)Cough						
20)Difficult breathing						

<u>Part 4</u> Behavior of pesticide use

Instruction: Please tick(/) in the brackets. You can choose only one answer for each item

Behaviors	Always done	Often done	Some time done	Rare done	Never
1. Carefully read pesticide use instructions before use and also strictly follow the instructions					
2. Chief or health staff explain chemical safety and hazard and know health hazard					
3. Use expired pesticide					
4. Open pesticide container by using your mouth					
5. Blow or suck the nozzle by using your mouth					
6. Mix or stir pesticide with hand without glove					
7. Stop working immediately when you get wounded during the spray of pesticide					
8. Spray pesticide in the same direction as the wind					
9. Drink water or eat some food during spray pesticide					
10. Take a shower immediately after spray pesticide					
11. Change clothing after spray pesticide before go home					
12. Separate contaminated pesticide clothes from others to clean					
13. Wash pesticide equipment and pesticide container					
14. Store pesticide in locked or safe area					
15. Burn or disposal the expired or left over pesticide in the safety area					

Appendix B

Lung Function Test Form

Participant's No.....Date.....Start-End Time.....
District....., Bangkok, Thailand

BEFORE STARTING THIS QUESTIONNAIRE PLEASE ASK THE FOLLOWING QUESTIONS

Have you had a cigarette in the last **hour**? YES ☐ NO ☐

Have you used an inhaler (puffer) in the last **hour**? YES ☐ NO ☐

IF 'YES' DELAY LUNG FUNCTION TESTS UNTIL ONE HOUR AFTER THE LAST CIGARETTE OR INHALER USE (RESPONSES DO NOT HAVE TO BE INCLUDED IN DATA RECORDER)

NUMBER

1. How many times have you been woken at night with shortness of breath in the last ***two weeks****?* ☐☐

2. During the last ***two weeks,*** has your breathing been **TICK ONE BOX ONLY**

(a) worse than usual? ☐

(b) same as usual? ☐

(c) better than usual? ☐

NO YES

3. Have you had wheezing or whistling in your chest **in the last 3 days?** ☐☐

4. Have you woken up with a feeling of tightness in your chest

in the last 3 days? ☐☐

NO YES

5. Have you been woken by an attack of shortness of breath **in the last 3 days?** ☐☐

6. Have you been woken by an attack of coughing **in the last 3 days?** ☐☐

7. Have you had an attack of asthma **in the last 3 days?** ☐☐

8. Have you taken any medicine (including inhalers, aerosols and tablets) for asthma **in the last 3 days?** ☐☐

9. Have you had any symptoms of hay fever or nasal allergy in the **last 3 days?**

10. Have you had a respiratory infection in the **last 3 weeks?** ☐☐

IF 'YES' AND THE SUBJECT IS WILLING TO COME BACK, STOP AND MAKE A NEW APPOINTMENT. IF NOT, PROCEDE WITH QUESTION 10.1

DAY

10.1 How many days ago did it end? ☐☐

NO YES

11. Have you used an inhaler in the last **24 hours**? ☐☐

IF THE SUBJECT HAS USED A BETA-2-AGOINST INHALER OR AN ANTIMUSCARINIC INHALERIN THELAST FOUR HOURS, CONSIDER: -

a) WAITING UNTIL FOUR HOURS SINCE LAST USE HAS ELASPED

b) RESCHEDULING FOR ANOTHER DAY IF THE SUBJECT IS WILLING, IF NEITHER OF THESE IS POSSIBLE, PROCEED.

IF THE SUBJECT HAS TAKEN AN ORAL BETA-2-AGOINST, AN ORAL THEOPHYLLINE OR AN ORAL ANTI-MUSCARINIC, CONSIDER RESCHEDULING FOR ANOTHER DAY IF THE SUBJECT IS WILLING, IF THIS IS NOT POSSIBLE, PROCEED.

	NO	YES
12. Have you had a heart attack in the last **three months**?	☐	☐
13. Are you currently taking any medicine(s) for your heart?	☐	☐
14. Are you currently taking any medicines for epilepsy?	☐	☐
15. Are you currently taking any medicine containing beta-blockers, **including eye-drops**?	☐	☐

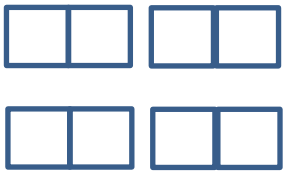
IF 'YES' TO ANY QUESTIONS 13-16 MEASURE BASELINE SPIROMETRY ONLY,
DO NOT CHALLENGE.

General Information

1. Subject's Height METRES ☐ ☐☐
2. Subject's Weight KILOGRAMS ☐☐
3. Subject's Age AGE ☐☐
4. Subjects sex
Male Female ☐☐

HOURS MINUTES

5.Time of Day ‘24 hrs’



Spirometer

Instrument number

If additional readings are made, enter below number 5 and delete the ones they replace.

FVC (litres) FEV(litres)

1 □□□□ □□□□

2 □□□□ □□□□

3 □□□□ □□□□

4 □□□□ □□□□

5 □□□□ □□□□

Additional observations

……

……

Peak expiratory flow

If additional readings are made, enter below number 5 and delete the ones they replace

PEFR (litres/min)

1 □□□□

2 □□□□

3 □□□□

4 □□□□

5 □□□

Additional observations

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APPENDIX C

BIOLOGICAL SAMPLING FORM

Analysis number.....Project name.....
Name who collect sampling.....tel.....
Date of sent sampler.....time.....Name of sent sampler.....tel.....
Name who receive sample.....Date of receive sample.....time.....

Sample No.	Date	Time	Id subject	location	Volume(ml)	Type of sampler	Parameter	Remark

Addition
note.....
.....
.....

APPENDIX D

Air sampling Form

Analysis number.....Project name.....
Name who collect sampling.....tel.....
Date of sent sampler.....time.....Name of sent sampler.....tel.....
Name who receive sample.....Date of receive sample.....time.....

Sample Location	Start Date	Start time	End Date	End Time	Flow Rate (Liters per minute)	Total Length of Sampling Period (min)	Total Volume of Air Pumped through Tube (Liters)

Sample Location	Temp Start (F)	Barometric Pressure Start (Inches)	Temp End (F)	Barometric Pressure End (Inches)	Comments

APPENDIX E

INTERVENTION PLAN

TOPIC : **Introduction Chemical Safety Training (6 hrs)**

Objective :1. To explain basic safe use of chemicals at places of work
2. To present classification systems for the labeling and how the read and use of chemical safety card.
3. To give a basic overview of toxicology and chemical hazard.
4. To give a basic chemical safe use, storage and personal hygiene.
5. To explain and demonstrate wear personal protective equipment (PPE)

Contents :- Introduction to safety in the use of chemicals spraying. (0.5 hrs)
- What is toxicology and chemical hazard? (1.5 hrs)
- Identification, classification and labeling of chemicals (1.0 hrs)
- Basic chemical safe use, storage and personal hygiene (1.0 hrs)
- Personal protective equipment (PPE) (2.0 hrs)

Training activities

1) The level of the course will assess in order to meet the needs of the target group.
2) Greeting the participants and introduction himself.
3) Telling the participants about topic, objective and contents of training course
4) Showing video about chemical exposure, hazard, health effect due to chemical exposure.
5) Asking the participants about previous chemical exposure experience while chemical spraying.
6) Showing and giving a book and brochures
7) Explain Introduction to chemical safety, toxicology, Identification, classification and labeling of chemicals
8) Explain and show a basic chemical safe use, storage and personal hygiene
9) Explain and demonstrate how wear personal protective equipment (PPE)
10) Q&A

Training media : -Power point presentation
-Video
-Booklet
-Brochures

Assessment &Evaluation 1) The results of evaluation form
2) Observation of participants are wearing PPE.

TOPIC : Respirator Fit Test Program (**6 hrs**)

Objective : 1. To explain and demonstrate all parts of respirator and maintenance
] 2. To demonstrate Respirator Fit Test technique and practice vector
control operators about Respirator Fit Test both positive and negative technique.

Contents : - How to respirator maintenance and inspection? (1.5 **hrs**)
- What is the positive and negative fit test technique? (1.5 **hrs**)
- Positive and negative fit test technique practices. (3.0 **hrs**)

Training activities

1)The trainer explain purpose the Respirator Fit Test Program

2)The trainer motivates participant and create a proper "climate" for learning by
Ask interest arousing questions.
Stimulate short discussion among learners.
Use photos or objects to develop interest.
Describe personal experience(s) involving ideas or skills which will be covered in the session.

3)The trainer explains and demonstrates all parts of respirator and how to maintenance and respirator fit test.

4) The trainer divides participant into 5 group, the number participants in each group is around 8-10 participants.

5) Assistant trainer demonstrates all parts of respirator and how to maintenance and respirator fit test in each group 2-4 times.

6) Each participants practice checks parts of respirator and positive and negative fit test for 2-4 times with assistant trainer recommends.

7) Assistant trainer evaluates every participant by asking parts of respirator and observation positive and negative fit test.

8) Question &Answer (Q&A)

Training media : -Power point presentation
-Video
-Booklet
-Brochures

Assessment &Evaluation 1) The results of evaluation form
2) Observation of participants.

Respirator Parts

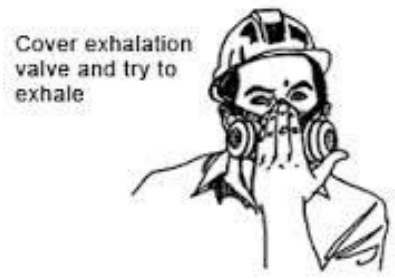
- Head harness
- Inhalation/exhalation flap
- Inhalation/exhalation connectors
- Cartridges

Maintenance and Care

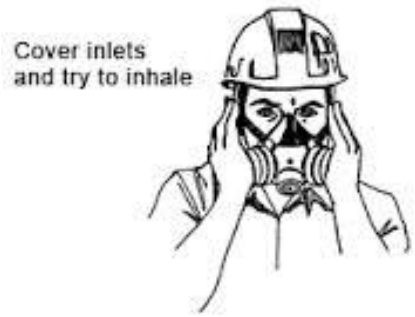
- After each use
  - Remove cartridges
  - Wash respirator with warm water and soap
  - Scrub with a brush (not wire)
  - Blot dry with a paper towel
  - Disinfect with provided disinfection wipes
- Store in bag provided when not in use
- Do not share respirators

Positive and Negative Pressure User seal check

Positive and Negative Pressure User seal check are simple and quick fit test, this method procedure are outlined in Canadian Standard Association (CSA) Z 94.4 4-02 which can be performed by the workers to check respirator fit any time during a work shift. Positive -pressure test is conducted by wearer cover the exhalation valve, usually located on the bottom of respirator, with palm of the hand and exhaling gently. The face piece should puff slightly away from the face without air to escape. Negative –pressure test involves covering air inlets and then inhaling. A slight collapse of face piece with no air leakage indicates that respirator a satisfactory fit.



Positive pressure test



Negative- pressure test

Appendix A

แบบสัมภาษณ์

หัวข้อ โปรแกรมความปลอดภัยสารเคมีเพื่อลดการสัมผัสด้านอาชีวอนามัยและปรับปรุงสุขภาพในกลุ่มพนักงานควบคุมสัตว์และแมลงนำโรคของกรุงเทพมหานคร

วันที่สัมภาษณ์.....เวลา.....สำนักงานเขต.....กรุงเทพมหานคร

<u>คำชี้แจงการสัมภาษณ์</u>

1. การสัมภาษณ์ครั้งนี้ มีวัตถุประสงค์เพื่อสอบถามข้อมูลทั่วไปเกี่ยวกับการทำงานที่สัมผัสสารเคมีขณะฉีดพ่นสารเคมีเพื่อควบคุมกำจัดยุงลาย ข้อมูลที่ได้จากการสัมภาษณ์ผู้วิจัยจะนำไปจัดทำมาตรการป้องกันและควบคุมโรคจากการทำงานอันเนื่องมาจากการสัมผัสสารเคมีขณะฉีดพ่นสารเคมี การสัมภาณ์จะติดตามสัมภาษณ์
   3 ครั้ง คือ ก่อนการดำเนินการ ระหว่างดำเนินการ และภายหลังการดำเนินกำหนดมาตรการป้องกัน
2. การสัมภาษณ์ของอาสาสมัครเป็นไปด้วยความสมัครใจ หากท่านไม่ต้องการตอบคำถาม สามารถข้ามข้อคำถามและไม่ต้องตอบคำถามได้
3. แบบสัมภาษณ์ประกอบด้วย 4 ส่วน ได้แก่ ส่วนที่หนึ่ง ข้อมูลทั่วไป พฤติกรรมส่วนบุคคล และประวัติสุขภาพ ส่วนที่สอง ข้อมูลเกี่ยวกับการทำงาน ส่วนที่สาม อาการเฉียบพลันจากการสัมผัสสารเคมี ส่วนที่ 4 พฤติกรรมความปลอดภัยการใช้สารเคมี
4. โปรดทำเครื่องหมาย / ลงใน ( ) ในช่องที่ต้องการตอบคำถาม
5. สารเคมี หมายถึง สารเคมีกำจัดแมลง และน้ำมันดีเซล ที่ใช้ผสมในการฉีดพ่นยุง
6. ลายมือชื่อของอาสาสมัคร.....

ส่วนที่ 1. ข้อมูลทั่วไป พฤติกรรมส่วนบุคคล และประวัติสุขภาพ

1. อายุ.....ปี
2. เพศ ( )ชาย ( )หญิง
3. น้ำหนัก.....กิโลกรัม ( ) ส่วนสูง.....เซนติเมตร
4. ระดับการศึกษา
   ( ) ประถมศึกษา ( ) มัธยมศึกษาต้น ม 1-ม3
   ( ) มัธยมศึกษาปลาย ม 4-6 ( ) ประกาศนียบัตรวิชาชีพ
   ( ) ปริญญาตรี ( ) อื่น ๆ โปรดระบุ.....
5. ท่านเคยสูบบุหรี่หรือไม่
   ( ) เคย ( )ไม่เคย
   ถ้าเคยสูบบุหรี่ ระยะเวลาจำนวนปีที่ท่านสูบบุหรี่ .....ปี

อายุเท่าไหรที่ท่านเริ่มสูบบุหรี่.....ปี

จำนวนบุหรี่ที่ท่านสูบ .....มวน/วัน

ปัจจุบันท่านยังสูบบุหรี่หรือไม่

( ) สูบ ( )ไม่สูบ ถ้าท่านตอบไม่สูบ อายุเท่าไหรที่ท่านเลิกสูบบุหรี่.....ปี

6. ท่านเคยดื่มสุราหรือไม่

( ) เคย ( )ไม่เคย

ถ้าเคยดื่มสุรา ระยะเวลาจำนวนปีที่ท่านดื่ม .....ปี

อายุเท่าไหรที่ท่านเริ่มดื่มสุรา.....ปี

จำนวนสุราที่ท่านดื่ม(ให้เลือกตอบ) .....แก้ว/วัน .....แบน/สัปดาห์ กลม/สัปดาห์

ปัจจุบันท่านยังดื่มสุราหรือไม่

( ) ดื่ม ( )ไม่ดื่ม

ถ้าท่านตอบไม่ดื่ม อายุเท่าไหรที่ท่านเลิกดื่มสุรา.....ปี

7. แพทย์เคยบอกท่าน ว่าท่านเป็นโรคต่อไปนี้หรือไม่ (สามารถตอบคำถามได้มากกว่า ๑ ข้อ)

( ) โรคปอดเรื้อรัง

( ) วัณโรค

( ) ถุงลมโป่งพอง

( ) หลอดลมอักเสบเรื้อรัง

( ) หอบหืด

( ) มะเร็งปอด

( ) โรคหัวใจ

( ) ความดันโลหิตสูง

( ) เบาหวาน

( ) อื่น ๆ โปรดระบุ.....

8. ท่านรับประทานอาหาร ประเภท น้ำผลไม้ เคก เจลลี่ หรือเนย เป็นประจำใช่หรือไม่

( ) ใช่ ( ) ไม่

ส่วนที่ 2 ข้อมูลเกี่ยวกับการทำงาน

9. ท่านทำงานเป็นพนักงานฉีดพ่นยุง.....ปี

10. ท่านมีโอกาสสัมผัสสารเคมีระหว่างทำงานขณะฉีดพ่นสารเคมีหรือไม่

( ) มีโอกาส ( ) ไม่มี

11. จากข้อ 9 ถ้าท่านมีโอกาสสัมผัสสารเคมีฉีดพ่นยุง จำนวนชั่วโมงต่อวันที่ท่านทำงานฉีดพ่นสารเคมี

( ) 1 ชั่วโมง/วัน ( ) 2 ชั่วโมง/วัน( ) 3ชั่วโมง/วัน ( ) มากกว่า 3 ชั่วโมง/วัน

12. กิจกรรมใดต่อไปนี้ที่ท่านมีโอกาสสัมผัสสารเคมีมากที่สุด
    ( ) การผสมสารเคมี
    ( ) การขนย้าย/กำจัดสารเคมี
    ( ) การฉีดพ่นสารเคมี
    ( ) การซ่อมบำรุงเครื่องฉีดพ่นสารเคมี
    ( ) การสัมสารเคมีที่ฉีดพ่นแล้ว
    ( ) การสัมผัสสารเคมีที่บ้านหรือใช้ชีวิตประจำวัน
13. เครื่องฉีดพ่นสารเคมีประเภทใดที่ท่านใช้ในการฉีดพ่นสารเคมี เพื่อควบคุมยุงลายมากที่สุด
    ( ) เครื่องฉีดพ่นสารเคมีแบบละอองฝอย
    ( ) เครื่องฉีดพ่นสารเคมีแบบบรรจุกระป๋องก๊าซอัดแรงดัน
    ( ) เครื่องฉีดพ่นสารเคมีแบบหมอกควัน
    ( ) เครื่องฉีดพ่นสารเคมีแบบปั๊มอัดแรงดัน
    ( ) เครื่องฉีดพ่นสารเคมี ชนิดอื่นๆ ระบุ.....
14. ส่วนผสมสารเคมีที่ใช้ในการฉีดพ่นยุง (ผู้สัมภาษณ์ ขอดูฉลากสารเคมีที่ติดบนภาชนะบรรจุภัณฑ์สารเคมีที่ใช้ในการฉีดพ่นยุง

ชนิด ประเภท ส่วนผสมสารเคมี	เปอร์เซนต์ส่วนผสม

15. ระหว่างการฉีดพ่นสารเคมี ท่านได้สวมอุปกรณ์ป้องกันอันตรายส่วนบุคคลตลอดเวลารือไม่
    ( ) สวมตลอดเวลา ( )สวมบ้างเป็นบางครั้ง ( ) ไม่สวม
    ประเภทของอุปกรณ์อันตรายส่วนบุคคล ที่ท่านสวมใส่ขณะทพงานฉีดพ่นสารเคมี (ผู้สัมภาษณ์สังเกตอุปกรณ์ที่พนักงานใช้พร้อมขอดูตัวอย่างอุปกรณ์)

ประเภทของอุปกรณ์อันตรายส่วนบุคคล	สวมอุปกรณ์	
	สวม	ไม่สวม
1.หน้ากากป้องกันสารเคมี		
2.ผ้าปิดจมูก		
3.แว่นตากันสารเคมี		
4.ถุงมือผ้า		
5.ถุงมือยาง		
6.ชุดป้องกันสารเคมี		
7.ชุดทำงานที่เป็นผ้าเสื้อแขนยาว กางเกงขายาว		
8.รองเท้าบูทยาง		
9.รองเท้าหุ้มส้น		

16. จากข้อที่ 14 ท่านความถี่บ่อยครั้งเท่าไร ที่สวมอุปกรณ์ป้องกันอันตรายส่วนบุคคลในการทำงาน

ประเภทของอุปกรณ์อันตรายส่วนบุคคล	สวมอุปกรณ์		
	เป็นประจำ	บางครั้ง	ไม่เคยใช้
1.หน้ากากป้องกันสารเคมี			
2.ผ้าปิดจมูก			
3.แว่นตากันสารเคมี			
4.ถุงมือผ้า			
5.ถุงมือยาง			
6.ชุดป้องกันสารเคมี			
7.ชุดทำงานที่เป็นผ้าเสื้อแขนยาว กางเกงขายาว			
8.รองเท้าบูทยาง			
๙.รองเท้าหุ้มส้น			

17. ท่านหรือหน่วยงานของท่าน มีวิธีการควบคุมลดหรือควบคุมสารเคมีหรือไม่
เช่น ผสมสารเคมีในภาชนะ หรือ บริเวณปิดชิด แยกเก็บสารเคมีที่เป็นสัดส่วน ใช้พัดลมระบายอากาศเฉพาะที่
( ) มี ( )ไม่มี
ถ้าท่านตอบ มีมาตรการควบคุม ท่านใช้มาตรการควบคุมสารเคมีใด
( ) ผสมสารเคมีในภาชนะที่ปิดชิด
( ) แยกเก็บสารเคมีไว้บรเวณเฉพาะ
( ) ใช้พัดลมระบายอากาศเฉพาะที่
( ) วิธีการอื่นๆ โปรดระบุ.....

18. หน่วยงานของท่านจัดให้มีเอกสารแสดงขั้นตอนการทำงานฉีดพ่นสารเคมีฉีดพ่นยุงเพื่อความปลอดภัยหรือไม่ (ผู้สัมภาษณ์สอบถามและสังเกตสภาพแวดล้อมการทำงาน)
( ) มี ( )ไม่มี

19. ท่านเคยได้รับการอบรมเกี่ยวกับความปลอดภัยการใช้สารเคมีฉีดพ่นยุงและวิธีการใช้งานอุปกรณ์ป้องกัน
อันตรายส่วนบุคคลหรือไม่
( ) เคย ( )ไม่เคย
ถ้ามี เคยอบรมครั้งล่าสุดเมื่อ.....โดย.....

ส่วนที่ 3 อาการหรืออาการแสดงเฉียบพลันจากการทำงานสัมผัสสารเคมีฉีดพ่นยุง

20. ท่านเคยมีอาการหรืออาการแสดงต่อไปนี้หรือไม่

อาการ อาการแสดง	ระหว่างการทำงาน		หลังฉีดพ่นสารเคมี		ไม่ได้ฉีดพ่นสารเคมี	
	ใช่	ไม่ใช่	ใช่	ไม่ใช่	ใช่	ไม่ใช่
1) แสบ ร้อนบริเวณใบหน้า						
2) ชาบริเวณมือ						
3) คันที่มือ ที่บริเวณรอบดวงตา ใบหน้า หรือ น้ำตาไหล						
4) คัดจมูก						
5) เจ็บคอ						
6) เป็นผื่น คันที่ผิวหนัง						
7)อ่อนเพลีย						
8)กล้ามเนื้ออ่อนแรง						
9)ง่วง ซึ่งซึม						
10) เวียนศีรษะ						
11) ปวดศีรษะ						
12)สับสน กระสับกระส่าย						
13) ตื่นเต้นตลอดเวลา						
14)ตามัว						
15)คลื่นไส้						
16) อาเจียน						
17) ปวดท้อง						
18) หายใจเสียงหอบดังมีเสียงวี๊ด						
19)ไอ						
20.หายใจลำบาก อึดอัด						

ส่วนที่ 4 พฤติกรรมความปลอดภัยการใช้สารเคมี

คำแนะนำการสังเกตพฤติกรรม ให้ทำเครื่องหมาย / ในช่องระดับพฤติกรรมความปลอดภัยการใช้สารเคมีฉีดพ่นยุงในแต่ละข้อ

พฤติกรรม	เป็นประจำ	บ่อยครั้ง	บางครั้ง(3)	น้อยครั้ง	ไม่เคยเลย
16. อ่านฉลากกำกับและข้อแนะนำการใช้สารเคมีก่อนการใช้งาน					
17. หัวหน้าหรือผู้ควบคุมอธิบายอันตรายจากสารเคมีและวิธีปฏิบัติงานที่ปลอดภัย					
18. ใช้สารเคมีที่หมดอายุ **หมด**สภาพการใช้งาน					
19. ใช้ปากเปิดปากถุง ภาชนะบรรจุภัณฑ์สารเคมี					
20. ใช้ปาก เป่าหรือดูดสารเคมี					
21. ผสมสารเคมีโดยไม่ใช้ถุงมือผสมสารเคมี					
22. หยุดปฏิบัติงานทันทีเมื่อมีบาดแผลขณะทำการพ่นสารเคมี					
23. ทำการพ่นสารเคมีตามทิศทางลม					
24. ดื่มน้ำและรับประทานอาหารในขณะทำการฉีดพ่นสารเคมี					
10.อาบน้ำทันทีหลังการฉีดพ่นสารเคมี					
11.เปลี่ยนชุดพ่นสารเคมีก่อนกลับบ้าน					
12.แยกเสื้อผ้าชุดที่ปนเปื้อนสารเคมีออกจากเสื้อผ้าอื่นเพื่อซักทำความสะอาด					
13.ทำความสะอาดเครื่องมือ ภาชนะที่เก็บสารเคมี					
14.เก็บสารเคมีในสถานที่ปลอดภัย มีห้อง หรือบริเวณแยกเก็บสารเคมีโดยเฉพาะ					
15.เผาหรือกำจัดภาชนะที่ปนเปื้อนสารเคมีด้วยวิธีถูกต้อง และในพื้นที่ปลอดภัย					

Appendix B

แบบตรวจสมรรถภาพปอด

หมายเลขอาสาสมัคร.....วันที่ตรวจ.....เวลาเริ่มตรวจ.....เวลาที่ตรวจเสร็จ.....
สำนักงานเขต.....ตรวจครั้งที่.....

คำชี้แจง

ก่อนเริ่มการทดสอบสมรรถภาพปอด โปรดตอบคำถามต่อไปนี้
-ท่านได้สูบบุหรี่เมื่อชั่วโมงที่แล้วหรือไม่
( ) ใช่ ( ) ไม่ใช่
-ท่านได้พ่นยาขยายหลอดลมเมื่อชั่วโมงที่แล้วหรือไม่
( ) ใช่ ( ) ไม่ใช่
ถ้าตอบคำถามว่า ใช่ ให้เลื่อนการทดสอบสมรรถภาพปอด ไปอีกอย่างน้อยหนึ่งชั่วโมง
หากไม่เลื่อนการทดสอบ จะมีผลต่อการทดสอบสมรรถภาพปอด
-อาสาสมัครต้องไม่เป็นโรคหัวใจ โรคปอดเรื้อรัง โรคถุงลมปอดโป่งพอง เพราะถ้าทดสอบสมารรถภาพปอดอาจมีผลกระทบต่อสุขภาพอาสาสมัครได้

๑. ส่วนสูง เมตร ☐☐☐

๒.น้ำหนัก กิโลกรัม ☐☐

๓. อายุ ปี ☐☐

4.เพศ

ชาย หญิง ☐☐

ไม่มีข้อห้ามในการเป่าปอด

☐ ไม่ไอเป็นเลือด ☐ ความดันโลหิตปกติ ☐ ไม่มีโรคหัวใจ (recent myocardial infarction)

☐ ไม่มีเส้นเลือดแดงโป่ง (aneurysm) ในทรวงอก ท้อง หรือสมอง

☐ ไม่ได้ผ่าตัดเร็วๆนี้ เช่น ลอกต้อกระจก ผ่าตัดช่องอก ช่องท้อง

☐ ไม่เป็นโรคติดเชื้อทางเดินหายใจ เช่น วัณโรคปอดระยะติดต่อ

☐ ไม่มีอาการเจ็บป่วยอื่นๆ คลื่นไส้ หรืออาเจียนมาก

☐ ถ้าเป็นสตรี-ไม่มีครรภ์

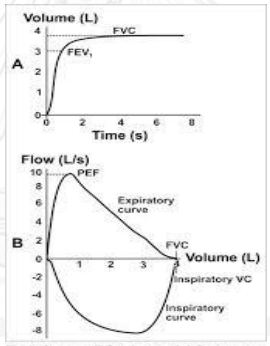
<u>คำแนะนำในการเป่าปอด</u>

1. เริ่มต้นถูกต้อง เป่าออกให้เร็ว และแรง (sharp take off, smooth curve) จากกราฟปริมาตร-เวลา
2. กราฟไม่มีข้อผิดพลาด ได้แก่ ไอ หายใจเข้าไม่เต็มที่ หายใจออกสั้นไม่สม่ำเสมอ มีการรั่วของลม มีลิ้น ฟันปลอมอุด mouth piece
3. หายใจออกสั้นเกินไป ต้องให้ได้อย่างน้อย 6 วินาที ควรเป็น plateau อย่างน้อย 1 วินาที

<u>การควบคุมคุณภาพในการเป่าปอด</u>

1. FVC และ FEV1 ค่าที่มากที่สุด ต่างจากค่าที่รองลงมา ไม่เกิน 150 ml
2. ทำซ้ำได้ไม่เกิน 8 ครั้ง หรือผู้ทดสอบทำต่อไม่ไหว

<u>การคัดเลือก Spirogram</u> เลือกกราฟที่มีผลรวม FVC และ FEV1 มากที่สุด



ผลตรวจสมรรถภาพปอด

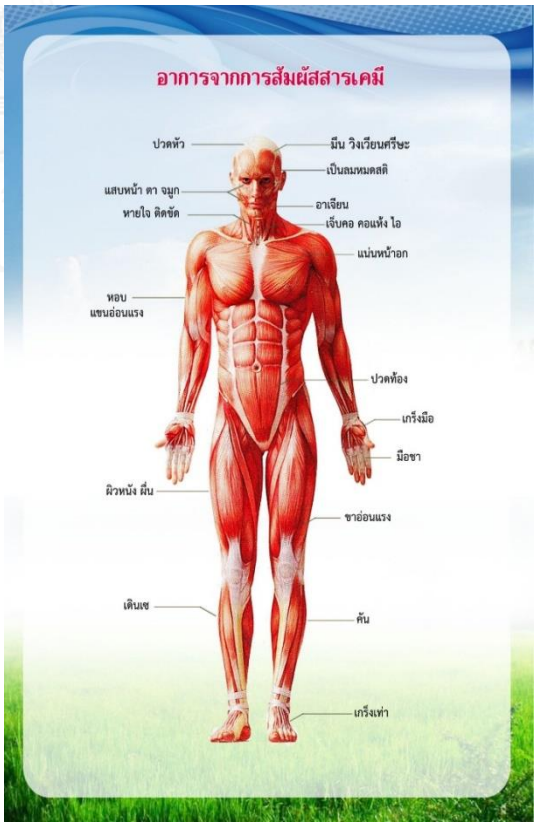
หมายเลขเครื่องมือ ☐☐☐☐

ครั้งที่	FEV1(ลิตร)	FVC(ลิตร)	Peak expiratory flow (ลิตร/นาที)
1			
2			
3			
4			
5			


คู่มือ
ความปลอดภัยด้านสารเคมีสำหรับ
พนักงานควบคุมสัตว์และแมลงนำโรค


ความปลอดภัยและอันตรายต่อสุขภาพจากการปฏิบัติงาน
ฉีดพ่นสารเคมีเพื่อควบคุมสัตว์และแมลง
คำนำ
ปัจจุบันสารเคมีมีบทบาทสำคัญในการควบคุมและป้องกันโรคด้านสาธารณสุขในหน่วย
งานองค์การปกครองส่วนท้องถิ่นหรือหน่วยงานด้านสาธารณสุขเพื่อควบคุมป้องกันโรค
ในพื้นที่ที่เกิดการระบาดของโรคตามแหล่งชุมชนและพื้นที่สาธารณะ ที่มีสัตว์และแมลง
นำโรคเป็นพาหะ เช่น การฉีดพ่นสารเคมีควบคุมป้องกันไข้เลือดออก การฉีดพ่น
สารเคมีเพื่อกำจัดยุงลำคาญ ป้องกันไข้สมองอักเสบ การฉีดพ่นสารเคมี กำจัดยุง
ก้นปล่อง เพื่อควบคุมโรคมาลาเรีย เป็นต้น นอกจากนี้ยังใช้สารเคมีควบคุมแมลงสาบ
และแมลงวัน


อันตรายจากการฉีดพ่นสารเคมี
สารเคมีกำจัดสัตว์และแมลงนำโรคส่วนผสมส่วนใหญ่มีสารเคมีกำจัดสัตว์และแมลงผสม
สารทำลาย เช่น น้ำมันดีเซล น้ำมันเบนซิน สารเคมีดังกล่าวจะมีผลทำลายระบบประสาท
ส่วนกลาง ระบบการไหลเวียนเลือด หรืออวัยวะภายในของสัตว์และแมลงนำโรค จึงสามารถ
ส่งผลกระทบต่อสุขภาพต่อผู้ปฏิบัติงานได้หากผู้ปฏิบัติงาน ฉีดพ่นสารเคมีไม่สวมอุปกรณ์
ป้องกันส่วนบุคคล การผสมสารเคมี หรือเทคนิคการฉีดพ่นสารเคมีหรือสุขวิทยาส่วนบุคคล
ไม่ถูกต้อง
ทางเข้าสารเคมีเข้าสู่ร่างกาย
ทางเข้าที่สารเคมีเข้าสู่ร่างกายมี 3 ทาง ได้แก่ การสัมผัส ทางผิวหนัง การกิน การหายใจ
การสัมผัสทางผิวหนัง เป็นการผสมสารเคมีโดยไม่สวมถุงมือ สัมผัสละอองไอ
ควันหรือของเหลวสารเคมีทางผิวหนังการดูดซึมสารเคมีจากชุดฉีดพ่นสารเคมี
การกินสารเคมีหรืออาหาร น้ำดื่ม เครื่องดื่มขณะทำงานฉีดพ่นสารเคมี
การหายใจ เอาไอระเหยฝุ่นละออง ควันจากการฉีดพ่นสารเคมี
หายใจ
สัมผัส
ทางผิวหนัง
กิน


อาการจากการสัมผัสสารเคมี
ปวดหัว
มึน วิงเวียนศีรษะ
เป็นลมหมดสติ
แสบหน้า ตา จมูก
หายใจ ติดขัด
อาเจียน
เจ็บคอ คอแห้ง ไอ
แน่นหน้าอก
หอบ
แขนอ่อนแรง
ปวดท้อง
เกร็งมือ
มือชา
ผิวหนัง ผื่น
ขาอ่อนแรง
เดินเซ
คัน
เกร็งเท่า


ความรู้เรื่องวัตถุอันตราย
วัตถุอันตราย ตามพระราชบัญญัติวัตถุอันตราย พ.ศ. ๒๕๓๕ หมายถึง
(1) วัตถุระเบิดได้
(2) วัตถุไวไฟ
(3) วัตถุออกซิไดซ์และวัตถุเปอร์ออกไซด์
(4) วัตถุมีพิษ
(5) วัตถุที่ทำให้เกิดโรค
(6) วัตถุกัมมันตรังสี
(7) วัตถุที่ก่อให้เกิดการเปลี่ยนแปลงทางพันธุกรรม
(8) วัตถุกัดกร่อน
(9) วัตถุที่ก่อให้เกิดการระคายเคือง
(10) วัตถุอย่างอื่น ไม่ว่าจะเป็นเคมีภัณฑ์หรือสิ่งอื่นใด ที่อาจทำให้เกิดอันตราย แก่บุคคล สัตว์ พืช ทรัพย์ หรือสิ่งแวดล้อม


ผู้ซื้อผู้ใช้งานผลิตภัณฑ์สามารถตรวจสอบว่าเป็นวัตถุอันตรายทางสาธารณสุข ดังนี้
1) ผลิตภัณฑ์มีเลขทะเบียนวัตถุอันตรายที่ใช้ในบ้านเรือนหรือทางสาธารณสุข ซึ่งตรงกับใบสำคัญการขึ้นทะเบียนวัตถุอันตรายนั้น โดยมีเลขทะเบียนปรากฏอยู่บนฉลาก โดยอยู่ในกรอบรูปหมายเลข ๑๑.
๒) ฉลากของผลิตภัณฑ์และข้อความแสดงรายละเอียดของผลิตภัณฑ์ ซึ่งต้องมีรายละเอียด ดังนี้
2.1 รายละเอียดข้อความหรือเครื่องหมายที่จะต้องแสดงบนฉลาก
ชื่อการค้า
ชื่อสามัญ /สารเคมี /ชื่อวิทยาศาสตร์
อัตราส่วนของสารสำคัญ
ประโยชน์
วิธีใช้
คำเตือน/ข้อความระวัง
วิธีเก็บรักษา
ขนาดบรรจุ
ชื่อ/ที่ตั้ง ผู้ผลิต ผู้นำเข้า ผู้จัดจำหน่าย
12-2-00244-2-0099
XX-X-XXXXX-Y-YYYY


วัตถุอันตรายที่ใช้ในบ้านเรือนหรือทางสาธารณสุข เพื่อป้องกันและกำจัดแมลง เช่น แมลงสาบ มด ปลวก เห็บ หมัด และหนู เป็นวัตถุอันตรายที่ขึ้นทะเบียนตั้งอยู่ในการควบคุมดูแลของสำนักงานคณะกรรมการอาหารและยา
สารเคมีชีวพันธุ์ เป็นวัตถุอันตรายทางสาธารณสุข ประเภทหนึ่งที่กำจัดแมลงและสัตว์นำโรคที่ใช้ในกิจวัตร บ้านพักอาศัย สำนักงาน สวนสาธารณะ ชุมชน โรงเรียน โรงงาน โรงพยาบาล ร้านอาหาร หรือสถานีขนส่ง เป็นต้น
๒.๒ รายละเอียดของข้อความหรือเครื่องหมายที่อาจมีหรือไม่มีบนฉลาก ได้ ดังนี้
อาการเกิดพิษ (ถ้ามี)
วิธีแก้พิษเบื้องต้น (ถ้ามี)
คำแนะนำสำหรับแพทย์ (ถ้ามี)
วันหมดอายุการใช้ (ถ้ามี)
การทำลายภาชนะบรรจุ (ถ้ามี)


ผลิตภัณฑ์และการจัดฉลากระบบสากล GHS จัดกลุ่มความเป็นอันตรายของสารเคมี โดยจำแนกความเป็นอันตรายทางกายภาพ 16 ประเภท ความเป็นอันตรายต่อสุขภาพ เป็น 10 ประเภท และความเป็นอันตรายต่อสิ่งแวดล้อม 1 ประเภท
อันตรายทางกายภาพ
อันตรายต่อสุขภาพ

มาตรการความปลอดภัยการใช้สารเคมีเพื่อควบคุมสัตว์และแมลงนำโรค

1. การประเมินความเสี่ยง

การใช้สารเคมีไม่ถูกวิธีหรือมีการใช้สารเคมีที่ไม่ได้วางแผนกำหนดมาตรการความปลอดภัย อาจส่งผลกระทบต่อสุขภาพต่อผู้ใช้สารเคมี หรือทำลายสภาพแวดล้อม ก่อนการใช้สารเคมี จึงต้องประเมินความเสี่ยงดังนี้

1.1 สารเคมีที่ใช้มีทะเบียนถูกต้องตามกฎหมายหรือไม่

1.2 ผู้ใช้งานสารเคมีได้รับการฝึกอบรมความปลอดภัยใช้สารเคมีหรือไม่

1.3 หน่วยงานมีแผนนโยบายหรือมาตรการความปลอดภัยด้านความปลอดภัยสารเคมีหรือไม่

2. มาตรการป้องกันควบคุมความปลอดภัยสารเคมี

2.1 การเลือกใช้สารเคมี

- เลือกใช้สารเคมีที่มีเลขทะเบียนได้รับใบอนุญาตถูกต้องตามกฎหมายหรือไม่
- เลือกสารเคมีเป็นอันตรายน้อยต่อ คน สัตว์ และสิ่งแวดล้อม โดยให้อยู่จากสลากกำกับสารเคมี

2.2 การจัดเก็บสารเคมี

- มีโรงเรือนหรือห้องสำหรับเก็บสารเคมีไว้เป็นเฉพาะ มีป้ายบ่งชี้สารเคมีชัดเจน แยกเป็นสัดส่วน
- บริเวณที่จัดเก็บต้องแน่ใจว่าไม่ปนเปื้อนอาหาร น้ำ หรือเครื่องดื่ม
- เก็บสารเคมีห่างจากเด็ก
- สารเคมีที่เป็นสารอันตรายต้องจัดเก็บในบริเวณพื้นที่เฉพาะส่วนและมีคำแนะนำ ขั้นตอนการใช้สารเคมีที่ปลอดภัย
- ตรวจสอบความปลอดภัยของสถานที่จัดเก็บสารเคมีเป็นประจำ

มาตรการความปลอดภัยการใช้สารเคมีเพื่อควบคุมสัตว์และแมลงนำโรค

สถานที่เก็บสารเคมีแยกเป็นสัดส่วน

แยกประเภทสารเคมี

2.3 การขนส่งสารเคมี

- ภาชนะ เช่น กล่อง ขวด ขนส่งสารเคมีสภาพปลอดภัยไม่แตกชำรุด
- มีความระมัดระวังในการเคลื่อนย้ายขนส่งสารเคมีไม่ให้หกรั่วไหล หากรั่วไหลควรซับด้วยวัสดุดูดซับสารเคมีและจัดเก็บในภาชนะจัดเก็บสารเคมีที่ปิดมิดชิด
- ระหว่างการเคลื่อนย้ายสารเคมี พนักงานต้องสวมอุปกรณ์ความปลอดภัยสารเคม

2.4 ควรเตรียมและผสมสารเคมี

- ตรวจสอบเครื่องมืออุปกรณ์ให้แน่ใจว่าอยู่ในสถานที่พร้อมใช้งาน ไม่ชำรุด หากชำรุดให้งดการใช้งานจนกว่าจะซ่อมบำรุงแล้วเสร็จ
- ศึกษาคู่มือการใช้งานของเครื่องมืออุปกรณ์ให้เข้าใจรวมทั้งขั้นตอนการปฏิบัติงานที่ปลอดภัยในการใช้เครื่องมือ
- สวมอุปกรณ์ความปลอดภัยส่วนบุคคล เช่น ชุดป้องกันสารเคมี รองเท้าบูทยาง แว่นตา ถุงมือ และหน้ากากป้องกันสารเคมี
- ผสมและการเตรียมสารเคมีในบริเวณที่มีการระบายอากาศดีไม่ควรผสมและเตรียมสารเคมีในบริเวณที่มีคนอื่นทำงานอยู่
- จัดทำอุปกรณ์กักกรอง เพื่อการรั่วไหลและกระจายสารเคมี หากสารเคมีรั่วไหลให้ใช้วัสดุดูดซับสารเคมี จัดเก็บวัสดุที่ปนเปื้อนสารเคมีในภาชนะบรรจุของเสียอันตราย
- ทำความสะอาดเครื่องมืออุปกรณ์ โต๊ะผสมสารเคมีและพื้น

การฉีดพ่นสารเคมี

1. ประชาสัมพันธ์ให้ประชาชนได้รับทราบว่าจะมีการฉีดพ่นสารเคมี ให้ประชาชนปิดประตูหน้าต่างบ้านเรือน ปิดระบบแอร์ ปกปิดอาหารและน้ำดื่ม และแนะนำให้ประชาชนกลุ่มเสี่ยง เช่น เด็กอ่อน คนชรา ผู้ป่วย ให้หลีกเลี่ยงหายใจ หรือสัมผัสสารเคมี ขณะทำการฉีดพ่นสารเคมี
2. พนักงานฉีดพ่นสารเคมีสวมอุปกรณ์ป้องกันอันตรายส่วนบุคคล
3. ฉีดพ่นทวนเหนือลมโดยให้สังเกตจากหมอกควันของสารเคมีและให้งดการฉีดพ่นสารเคมีหากมีลมแรง
4. ปฏิบัติตามขั้นตอนการฉีดพ่นสารเคมีที่มีผู้มีอำนาจไว้ เช่น ปรับปรุงฉีดพ่นให้เหมาะสม หรือปรับแรงเครื่องฉีดพ่นให้มีแรงดันฉีดพ่นให้เหมาะสม
5. หลีกเลี่ยงรับประทานอาหาร เครื่องดื่ม หรือสูบบุหรี่ ขณะอยู่ในพื้นที่การทำงานหลังการฉีดพ่นสารเคมี
   - ทำความสะอาด เครื่องมืออุปกรณ์ฉีดสารเคมี
   - ล้างมือ หน้า ผิวหนัง อาบน้ำด้วยน้ำและสบู่ทันที หลังการฉีดพ่นสารเคมี
   - เปลี่ยนเครื่องแต่งกายที่สะอาดก่อนกลับบ้าน
6. ระวังอย่าใช้มือปนเปื้อนสารเคมีสัมผัสใบหน้า ดวงตา ขณะฉีดพ่นสารเคมี

การดูแลอุปกรณ์ความปลอดภัยส่วนบุคคล

การดูแลอุปกรณ์ความปลอดภัยส่วนบุคคลสามารถใช้งานได้อย่างมีประสิทธิภาพและความปลอดภัย โดยยึดหลัก 3 ประการ การตรวจสอบ ทำความสะอาด และจัดเก็บอย่างเหมาะสม ดังนี้

การตรวจสอบ

1. ความสมประกอบของอุปกรณ์
2. ร่องรอยความสะอาดของอุปกรณ์
3. ความยืดหยุ่นของของสายรัดและซีลยาง
4. การได้กลิ่นสารเคมีเมื่อสวมอุปกรณ์แล้ว
5. การรับรองความปลอดภัยของอุปกรณ์
6. ระยะการเสื่อมของอุปกรณ์ เช่น ไส้กรองหรือแผ่นสารเคมี

ทำความสะอาด

1. ล้างอุปกรณ์ความปลอดภัยสม่ำเสมอให้สะอาดด้วยน้ำผสมน้ำยาทำความสะอาดและใช้แปรงขัดทำความสะอาดได้
2. ใช้แอลกอฮอล์เช็ดทำความสะอาดบริเวณ ห้ามใช้แอลกอฮอล์เช็ดทำความสะอาดในส่วนที่เป็นยาง

การจัดเก็บ

1. จัดเก็บอุปกรณ์ความปลอดภัยในสถานที่สะอาด ไม่ปนเปื้อนสารเคมี
2. หลีกเลี่ยงจัดเก็บในสถานที่ที่สัมผัส ฝุ่น แสงแดด ความร้อน ความเย็น ความชื้นสูง
3. ถ้าเป็นหน้ากากควรจัดเก็บในถุง ป้องกันอากาศเข้า

อุปกรณ์ป้องกันอันตรายส่วนบุคคลสำหรับฉีดสารเคมี

การปฏิบัติงานฉีดพ่นสารเคมีเพื่อควบคุมศัตรูและแมลงนำโรค ผู้ปฏิบัติงานมีความเสี่ยงสัมผัสสิ่งแวดล้อมในการทำงานที่ไม่เหมาะสม เช่นสารเคมี เสียงดัง แมลง สัตว์กัดต่อย เป็นต้น นำไปสู่อันตรายต่อสุขภาพผู้ปฏิบัติงานและโรคจากการ ประกอบอาชีพได้ อุปกรณ์ป้องกันอันตรายส่วนบุคคลจึงมีความสำคัญในการป้องกันอันตรายและลดการสัมผัสจากการหายใจหรือสัมผัสทางผิวหนังจากสิ่งแวดล้อมในการทำงานได้

ประเภทอุปกรณ์ป้องกันอันตรายส่วนบุคคล

1. ชุดป้องกันสารเคมี เป็นชุดเสื้อแขนยาวกางเกงขายาว ทำด้วยวัสดุที่สามารถป้องกันการซึมผ่านสารเคมีหรือป้องกันการกระเซ็นสารเคมีที่สัมผัสทางผิวหนัง

2. หน้ากากป้องกันสารเคมี เป็นหน้ากากสำหรับกรองสารเคมี มีไส้กรองหรือแผ่นกรองชนิดต่างๆ สามารถกรองสารเคมี และกลิ่นจากการฉีดพ่นสารเคมี

3. แว่นครอบตา มีซีลยางครอบตา สามารถป้องกันของเหลวและไอระเหยสารเคมีเข้าสู่ตาได้

4. ที่อุดหูหรือที่ครอบหู ป้องกันเสียงดังจากเครื่องฉีดพ่นสารเคมี

5. ถุงมือยาง เป็นถุงมือยางทำด้วยวัสดุยางสังเคราะห์ หรือนีโอพรีน สามารถป้องกันสารเคมีซึมผ่าน เข้าสู่ร่างกายได้

6. รองเท้าบูทยาง เป็นรองเท้าบูทยางสังเคราะห์ที่สามารถป้องกันสารเคมีจากการเหยียบสัมผัสสารเคมีได้

การเลือกใช้ดูแลอุปกรณ์ป้องกันอันตรายส่วนบุคคล

1. อุปกรณ์ที่เลือกควรได้รับการตรวจสอบและมีมาตรฐานรองรับ
2. มีประสิทธิภาพสูงในการป้องกันอันตรายและทนทาน
3. มีน้ำหนักเบาสวมใส่สบาย เหมาะสมกับผู้ใช้และง่ายต่อการใช้งาน
4. บำรุงรักษาง่าย ชิ้นส่วนอะไหล่หาซื้อได้ง่าย
5. ให้ความรู้พนักงาน เรื่องการใช้งาน ประโยชน์ และการดูแลรักษา

วิธีการสวมใส่หน้ากากป้องกันสารเคมี

1. เลือกขนาดหน้ากากให้เหมาะสมกับรูปหน้า โดยให้พิจารณาจาก ความสูงระหว่างตากับติ่งกลางจมูก
2. ปรับความยาวของสายรัดศีรษะ
3. ครอบสายรัดศีรษะที่เป็นห่วงไว้บนศีรษะ แล้วดึงปลายรัดศีรษะทั้งสองข้างให้ตึง
4. เกี่ยวตะขอรัดศีรษะให้แน่น
5. ทดสอบความกระชับ โดยใช้ฝ่ามือปิดพลุมผิวหน้าตลับกรองให้มิดชิดแล้วหายใจเข้าช้าๆถ้าสวมหน้ากากกระชับแล้วหน้ากากจะยุบตัวกับใบหน้า ไม่มีอากาศรั่วผ่านขอบหน้ากาก ถ้าไม่กระชับให้ปรับสายรัดศีรษะ

คำเตือน

อายุการใช้งานของหน้ากากขึ้นอยู่กับปริมาณความเข้มข้นสารเคมีที่ฟุ้งกระจาย อุณหภูมิและความชื้น ถ้าผู้ฉีดพ่นสารเคมี มีอาการดังนี้

1. ได้กลิ่นสารเคมี
2. ระคายเคือง
3. หายใจแน่นอึดอัด

* ให้ปรับเปลี่ยนตลับกรองสารเคมี ซึ่งแสดงว่าไส้กรองสารเคมีเสื่อมคุณภาพแล้ว

การทดสอบความกระชับหน้ากากสารเคมี

เป็นการทดสอบประสิทธิภาพการสวมหน้ากากของพนักงาน สังเกตอากาศรั่วเข้าหรือออกจากการสวมหน้ากากหรือไม่ ส่วนใหญ่มักจะพบบริเวณรอบๆขอบหน้ากากรอบคางและจมูก ซึ่งจะเป็นทางเข้าของสารเคมีที่ไม่ผ่านกรองสารเคมี การทดสอบความกระชับของหน้ากาก มี 2 วิธี ได้แก่ ทดสอบความดันด้านบวก และทดสอบความดันด้านลบ

ทดสอบความกระชับ

ความดันบวก

ใช้มือปิดด้านอากาศออก

ความดันลบ

ใช้ฝ่ามือปิดด้านอากาศเข้า

หายใจออมและเข้า ค้างไว้ 10 วินาที ถ้ามีอากาศรั่วออก หรือมีการขอบจมูกให้ดึงสายรัดให้แน่น และทดสอบความกระชับใหม่ ถ้าไอยูกขอบหน้ากากจะยุบเข้า ออก ไม่มีอากาศรั่ว

การสวมหน้ากากสารเคมี

การสวมหน้ากากสารเคมี มีขั้นตอนการสวมง่ายๆ 3 ขั้นตอน ได้แก่ การเลือกขนาดหน้ากาก การสวมหน้ากาก และการทดสอบความกระชับของหน้ากาก

การเลือกขนาดของหน้ากาก

เนื่องจากพนักงานมีใบหน้าที่มีขนาดแตกต่างกัน ให้วัดความยาวระหว่างตาและปลายคางจมูก แสดงดังภาพ ซึ่งความยาวของหน้ากาก มีดังนี้

S = 9.5–11.5 ซม

M=11.5–12.5 ซม

L=มากกว่า 12.5 ซม

H

การสวมหน้ากาก

คลอบหน้ากากให้ชิดตาง

สายรัดคลอบศีรษะและดึงให้แน่น

COA No. 176/2558

ใบรับรองโครงการวิจัย

โครงการวิจัยที่ 111.1/58 : โปรแกรมความปลอดภัยสารเคมีเพื่อลดการสัมผัสด้านอาชีวอนามัยและการปรับปรุงสุขภาพในกลุ่มพนักงานควบคุมสัตว์และแมลงนำโรคของกรุงเทพมหานคร

ผู้วิจัยหลัก : นายไพฑูรย์ งามมุข

หน่วยงาน : วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย

คณะกรรมการพิจารณาจริยธรรมการวิจัยในคน กลุ่มสหสถาบัน ชุดที่ 1 จุฬาลงกรณ์มหาวิทยาลัย ได้พิจารณา โดยใช้หลัก ของ The International Conference on Harmonization – Good Clinical Practice (ICH-GCP) อนุมัติให้ดำเนินการศึกษาวิจัยเรื่องดังกล่าวได้

ลงนาม.....
(รองศาสตราจารย์ นายแพทย์ปรีดา ทัศนประดิษฐ)
ประธาน

ลงนาม.....
(ผู้ช่วยศาสตราจารย์ ดร.นันทรี ชัยชนะวงศาโรจน์)
กรรมการและเลขานุการ

วันที่รับรอง : 7 ตุลาคม 2558 **วันหมดอายุ** : 6 ตุลาคม 2559

เอกสารที่คณะกรรมการรับรอง

1) โครงการวิจัย
2) ข้อมูลสำหรับกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัยและใบยินยอมของกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัย
3) ผู้วิจัย
4) แบบสอบถาม

เลขที่โครงการวิจัย 111.1/58
วันที่รับรอง - 7 ต.ค. 2558
วันหมดอายุ - 6 ต.ค. 2559

เงื่อนไข

1. ข้าพเจ้ารับทราบว่าเป็นการผิดจริยธรรม หากดำเนินการเก็บข้อมูลการวิจัยก่อนได้รับการอนุมัติจากคณะกรรมการพิจารณาจริยธรรมการวิจัยฯ
2. หากใบรับรองโครงการวิจัยหมดอายุ การดำเนินการวิจัยต้องยุติ เมื่อต้องการต่ออายุต้องขออนุมัติใหม่ล่วงหน้าไม่ต่ำกว่า 1 เดือน พร้อมส่งรายงานความก้าวหน้าการวิจัย
3. ต้องดำเนินการวิจัยตามที่ระบุไว้ในโครงการวิจัยอย่างเคร่งครัด
4. ใช้เอกสารข้อมูลสำหรับกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัย ใบยินยอมของกลุ่มประชากรหรือผู้มีส่วนร่วมในการวิจัย และเอกสารเชิญเข้าร่วมวิจัย (ถ้ามี) **เฉพาะที่ประทับตราคณะกรรมการเท่านั้น**
5. หากเกิดเหตุการณ์ไม่พึงประสงค์ร้ายแรงในสถานที่เก็บข้อมูลที่ขออนุมัติจากคณะกรรมการ ต้องรายงานคณะกรรมการภายใน 5 วันทำการ
6. หากมีการเปลี่ยนแปลงการดำเนินการวิจัย ให้ส่งคณะกรรมการพิจารณาก่อนดำเนินการ
7. โครงการวิจัยไม่เกิน 1 ปี ส่งแบบรายงานสิ้นสุดโครงการวิจัย (AF 03-12) และบทคัดย่อผลการวิจัยภายใน 30 วัน เมื่อโครงการวิจัยเสร็จสิ้น สำหรับโครงการวิจัยที่เป็นวิทยานิพนธ์ให้ส่งบทคัดย่อผลการวิจัย ภายใน 30 วัน เมื่อโครงการวิจัยเสร็จสิ้น

VITA

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Education

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Professional experience

1992-Presents PresentEnvironmental sanitation officer.
Senior Professional Leve.
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Occupational and Environmental Health,
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Vector Control. Operators,Thailand" in
The 5th International Conference on Global Health
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